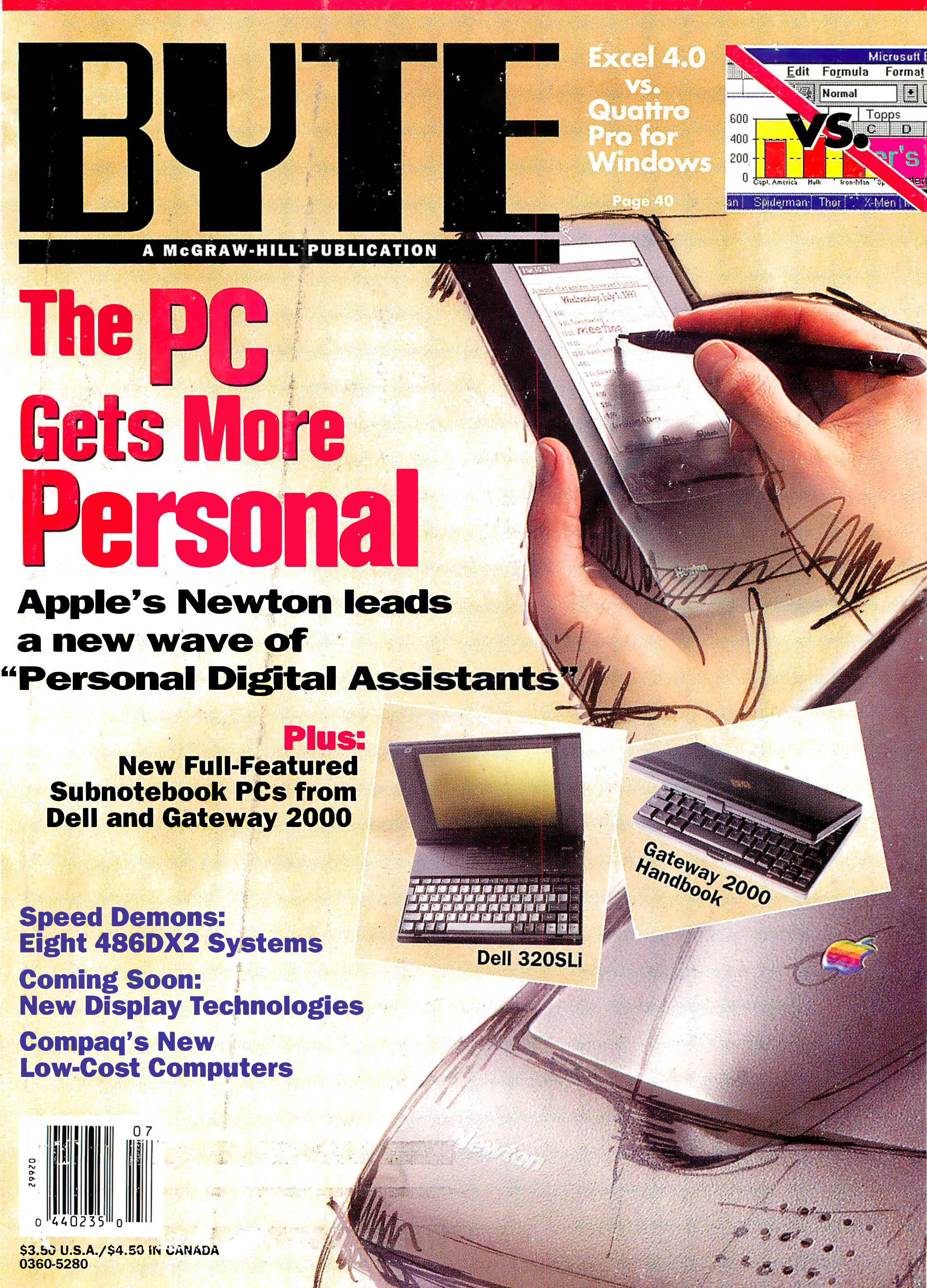
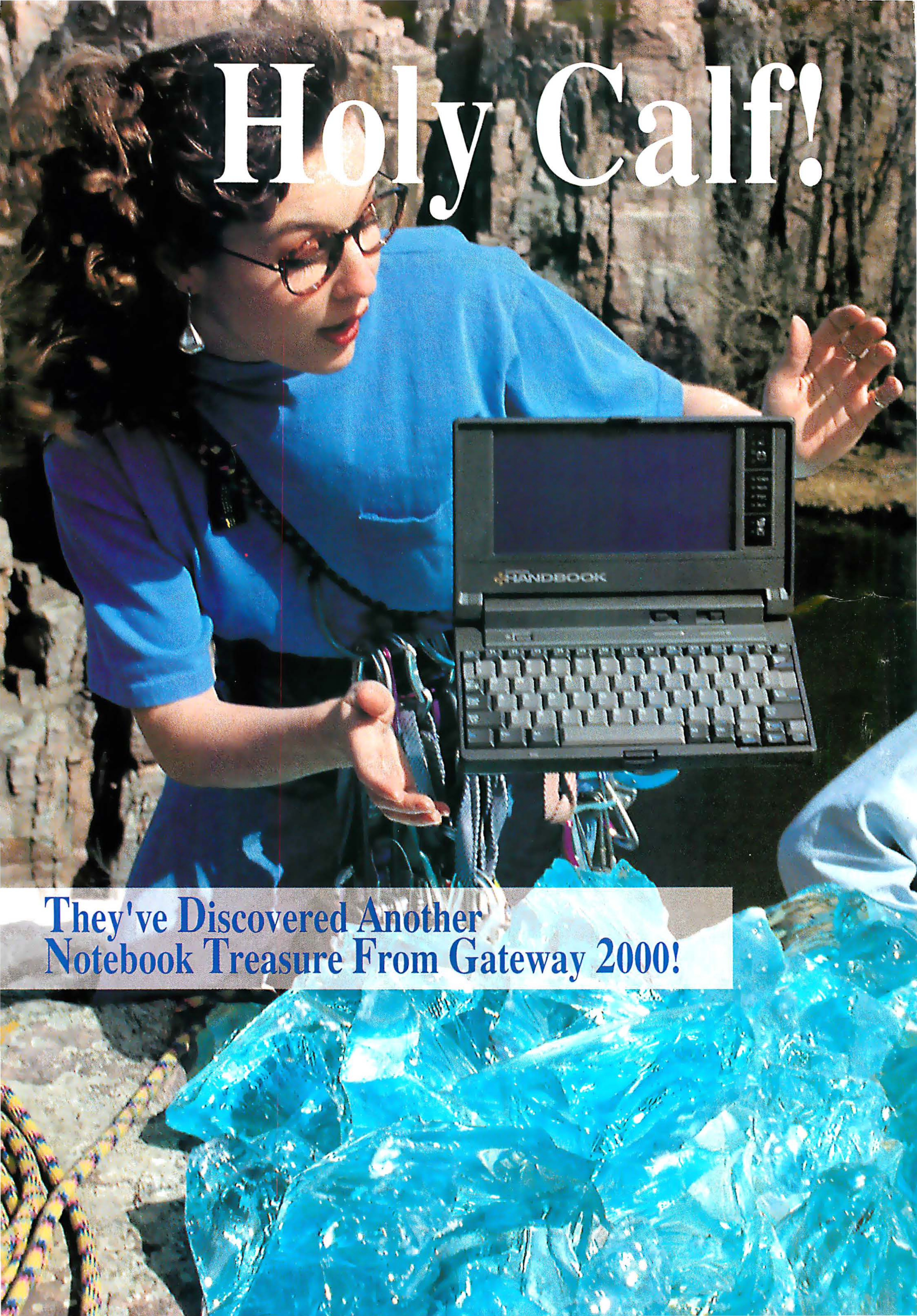
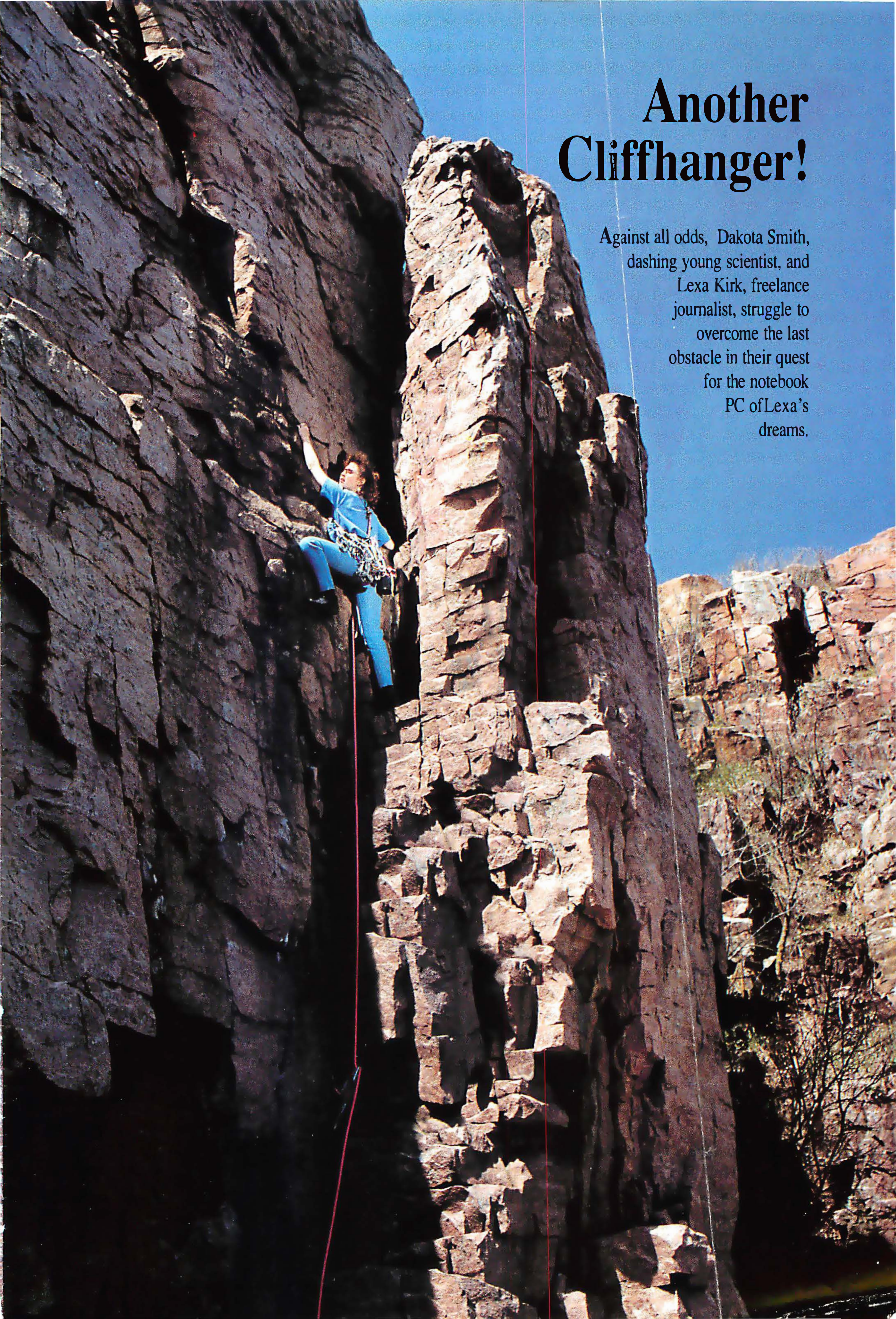

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Holy Calf!
HANDBOOK
They've Discovered Another
Notebook Treasure From Gateway 2000!





Another Cliffhanger!

Against all odds, Dakota Smith, dashing young scientist, and Lexa Kirk, freelance journalist, struggle to overcome the last obstacle in their quest for the notebook PC of Lexa's dreams.

The Explorers' Notes

The HandBook we discovered is a totally new notebook product — a real PC in miniature form!

HANDBOOK

- Weight 2.75 Lbs. (HandBook & Battery)
- Dimensions 5.9" x 9" x 1.4"
- 4-Hr.* NiMH Battery, 14-Oz. Charger, 6.5" x 2.5" x 1.5"
- Traveling Weight 3.5 Lbs. (HandBook, Battery & Charger)
- C & T® Processor, 286 Class Performance
- 1MB RAM
- 40MB Hard Drive
- Backlit 7.6" Double-Scan CGA Screen, 640 x 400 Resolution
- 1 Parallel/1 Serial Port
- 78-Key Keyboard, 101-Key Emulation, Inverted T Cursor Pad
- DOS, File Transfer Software & Serial Download Cable
- Introductory Bonus Pack
- Carrying Case

$1295

Options: FieldMouse pointing device, 2,400 bps modem, alkaline battery pack, portable printer, combo unit (3.5" drive with extra serial port and parallel port), extra batteries

In discovering the HandBook, we found what could be the first product in a new category of portable PCs. It's smaller and lighter than a notebook, but it's bigger and much more functional than a palmtop.

The HandBook's performance is comparable to a 286 system. Real PC features include a bright, backlit screen, a bonafide hard drive and a comfortable keyboard (no chiclet keys). Yet it weighs only 2.75 pounds. You can travel with the HandBook and not even know you're carrying it. When you get home, downloading information from your HandBook to your office computer is easy with the serial cable and file transfer software provided.

PC Magazine says, "Desktop PCs are faster (than notebooks)..." That was before we found the Nomads!

The Nomad notebooks we discovered are highly unusual. Our theory is they were designed to let you take desktop computer performance anywhere you go in a small, lightweight notebook. And using the patented power management system, we got over six hours of operation from a single battery on the 425DXL. Power management includes a 5.7 amp/hour battery and patented power-saving BIOS and software features.



The Nomad screens are bright and crisp. Resolution is 640 x 480, 64 gray scale, on the LCD. With 1MB video RAM, you can also display on an external monitor simultaneously. There's another Nomad characteristic that sets these notebooks apart from most others. They're made in the U.S.A.!

NOMAD Options: 2,400/9,600 bps modems, portable printer, numeric keypad, Token Ring or Ethernet interfaces, SCSI interface, memory upgrades, executive carrying case, extra batteries

**Battery life was measured with power management enabled.*

NOMAD

- Weight 5.8 Lbs. (Nomad & Battery)
- Dimensions 8.5" x 11" x 1.8"
- 6-Hr.* NiCad 5.7Ah Battery
- 14.4-Oz. Battery Charger, 6.12" x 2.25" x 1.5"
- Traveling Weight 6.7 Lbs. (Nomad, Battery & Charger)
- Backlit 10" VGA Screen, 640 x 480 Resolution, 64 Gray Scale
- Simultaneous Video with 1MB
- 1.44MB 3.5" Diskette Drive
- 1 Parallel/1 Serial Port
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Show me a new workstation with better numbers, and you'll get my attention.

Show me one with better ideas, and you'll get my order.

Introducing SPARCstation 10.



The new Sun™ SPARCstation™ 10 system is four times more powerful than any workstation we've ever made.

We also think you'll find it a hundred times more interesting than any workstation anyone else has ever made.

More interesting, because it runs your applications better than other desktops. Because you can upgrade to future processors about as easily as you can change a light bulb. And because it doesn't trade off backward compatibility for the sake of forward thinking.

In other words, the SPARCstation 10 is not just a new model.

It's an entirely new computer.

The only performance that matters.

What good is a turbo-powered engine if the car's transmission is sluggish? Or its tires are flat?

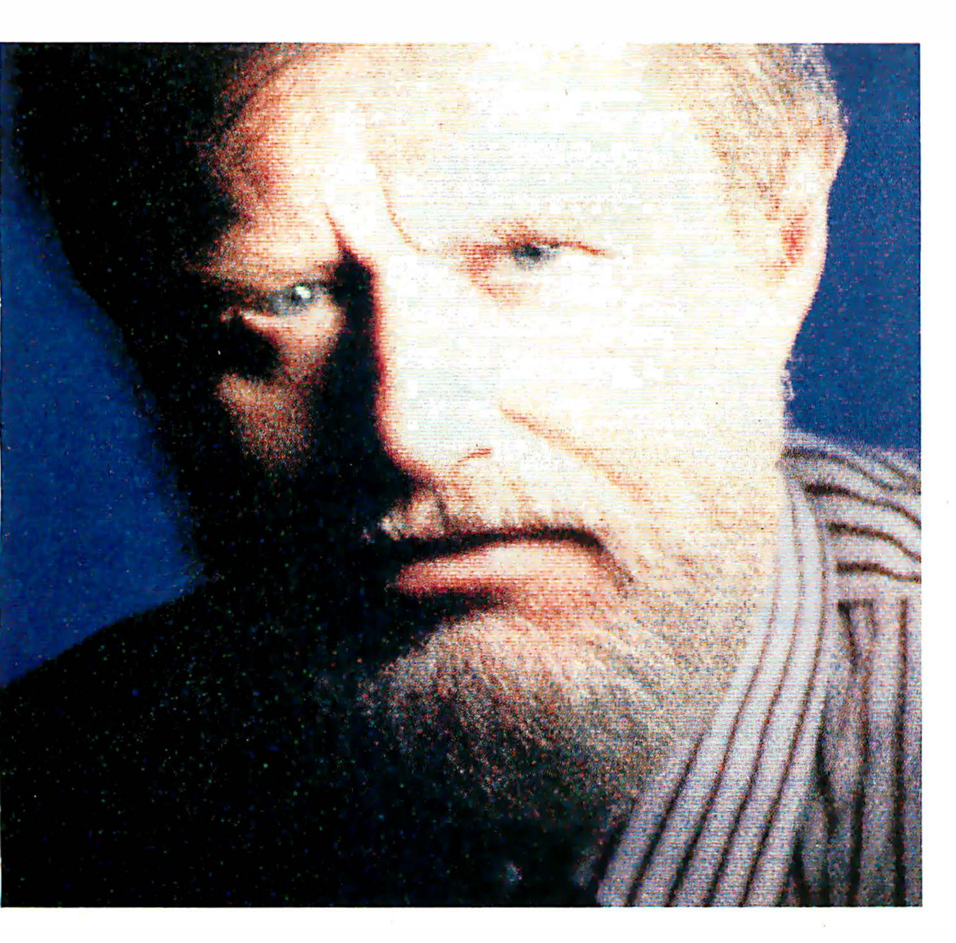
Our point is that building faster CPUs makes little difference if the rest of the computer can't keep up.

So for the SPARCstation 10 we devised an entirely new workstation. Not only with a faster CPU, but with a faster system bus, faster input/output, faster networking, and built-in multiprocessing.

The faster CPU is our new SuperSPARC™ chip. Remarkably, it can handle three instructions at once (most others manage only one or two). It's binary compatible with previous generations of SPARC.® And it runs the Solaris® operating environment, so you can use thousands of existing applications.

We teamed all that horsepower with the extra performance of multiprocessing. One megabyte of SuperCache™ memory. A 320MB-per-second peak memory bandwidth. A 10MB-per-second SCSI disk controller. And a large I/O buffer for faster Ethernet transfers.

Individually, each of these represents



a big step forward in computing performance. But together they produce an astonishing leap ahead in application performance.

And to the person whose hands are on the keyboard, that's the only kind that matters.

Growing up vs. growing old.

Though budgets have never been tighter, most workstations are still designed around the hope that you'll replace last year's computer just to work with a newer processor.

The SPARCstation 10 was designed around a different philosophy:

Make the processor replaceable, not the workstation.

To that end, we put the processor on a small SPARC module. As faster chips become available, you can upgrade by pulling out the old module and plugging in a new one.

The rest of your investment — memory, storage, accelerators, everything — is left intact.

But don't feel you have to wait around for faster chips. You have the freedom to grow a SPARCstation 10 in plenty of ways right now.

You can start by plugging in a second SPARC module. Since this machine was engineered throughout for symmetric multiprocessing, you'll nearly double its processing power.

You can also boost its memory to 512MB. And its disk capacity to 26GB.

There are ports for both parallel and serial devices; connections for thick, thin, or twisted-pair Ethernet; even ISDN connectors for networking over public telephone lines. All built in. Which leaves its four expansion slots available for other functions.

The future is not an option.

How long have you been hearing about promising new technologies like multiprocessing? Multimedia? ISDN?

And how many workstations can you name that give you all these capabilities, right out of the box?

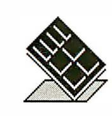
There's only one.

You've already read how the SPARCstation 10's multiprocessing can speed up the applications you run today. But it also means you can add enough horsepower later to run next-generation software built around multithreading and object management.



Multiprocessing Performance

Then there's ISDN. It brings the worldwide telephone network directly into the computer — without a modem. Which allows applications to make faxing, voicemail, and even video conferencing as natural as printing.



Plug-In SPARC Modules

A 16-bit audio chip and external speaker are also included. So applications can use CD-quality sound for e-mail, spoken tutorials, and multimedia presentations.



Binary Compatible

And there's enough memory, disk space, and bus bandwidth to meet the enormous demands of animation, simulations, and real-time video.

Admit it, you're intrigued.

You can't have read this far without feeling at least a twinge of excitement.

Maybe it's for the swift kick-in-the-pants this machine can give to the applications you're running today.

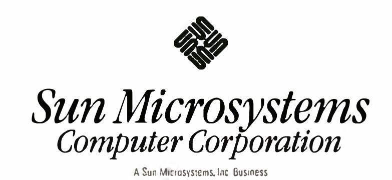
Or the enthusiastic way it welcomes whatever new technologies may be around the corner.

Maybe you simply can't help but respect a computer that offers your business a lot more than just MIPS and MFLOPS.

Whatever you think, here's what to do:

Call 1-800-426-5321, ext. 485 for complete information on the new Sun SPARCstation 10, or the name of your Sun reseller or sales representative.

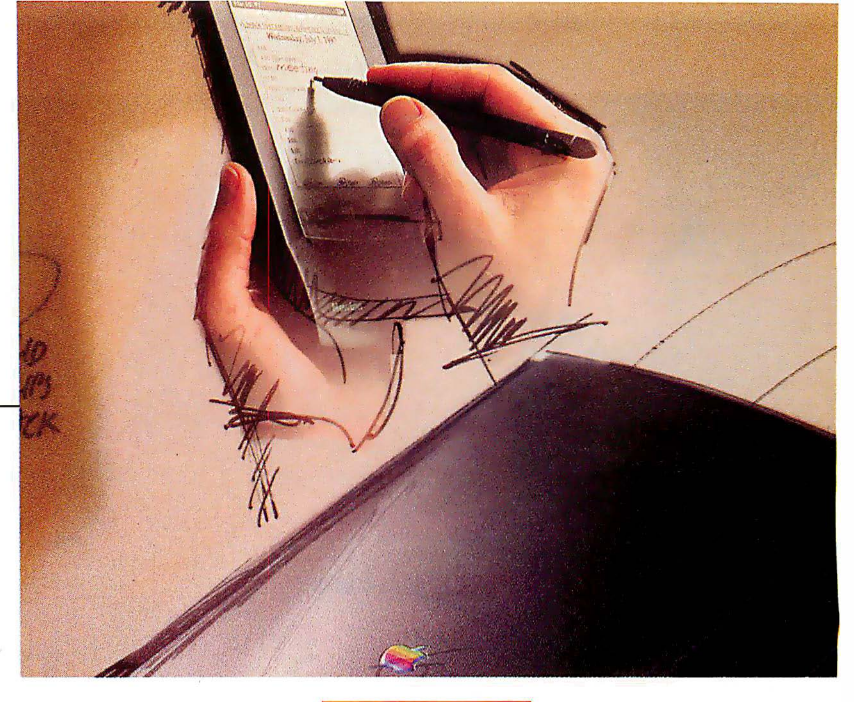
It's the first workstation to combine such powerful numbers with such potent ideas.



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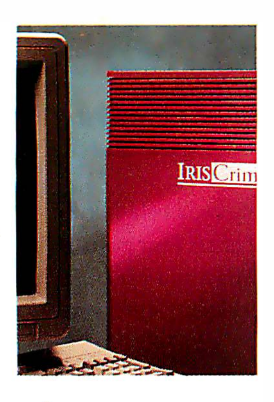
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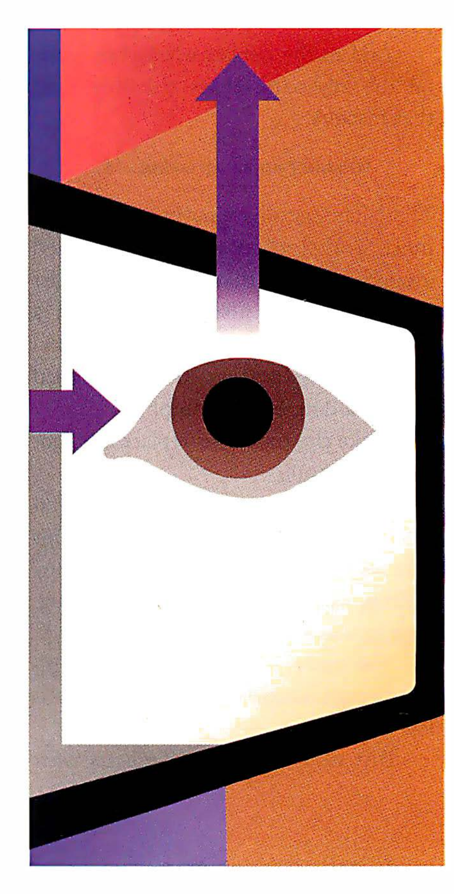
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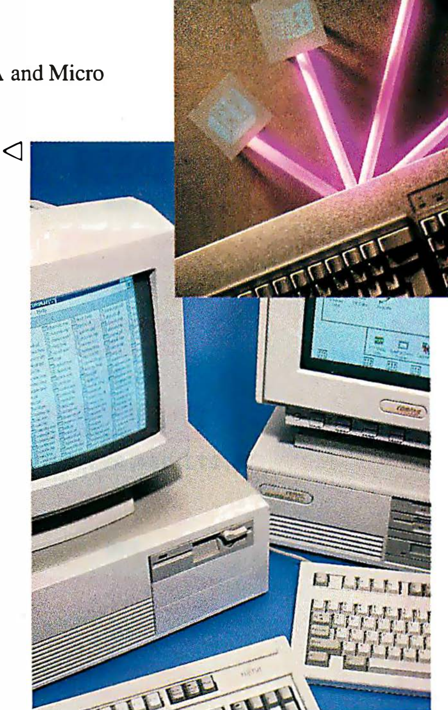


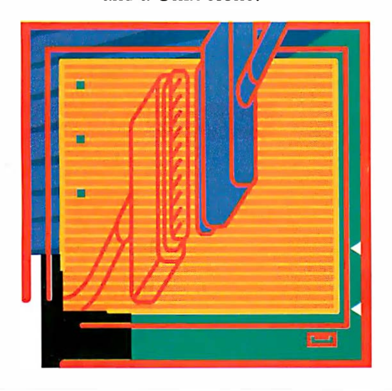
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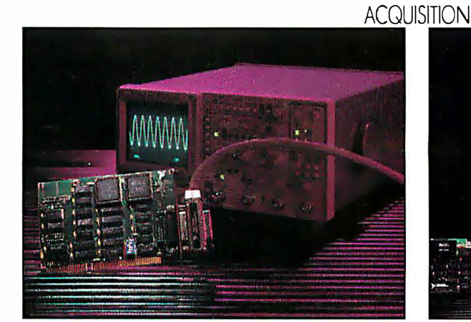
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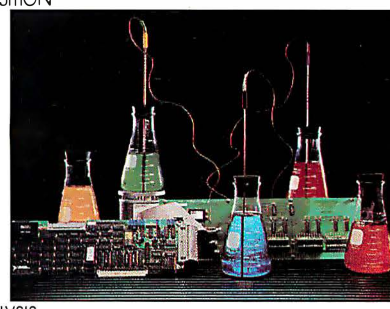
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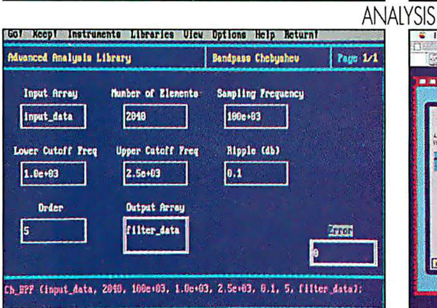
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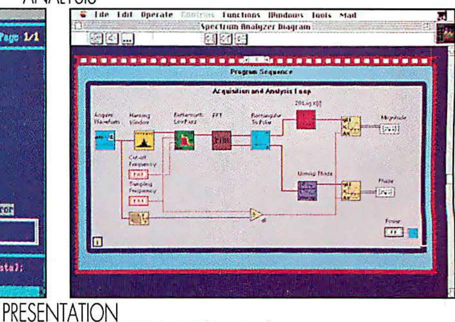
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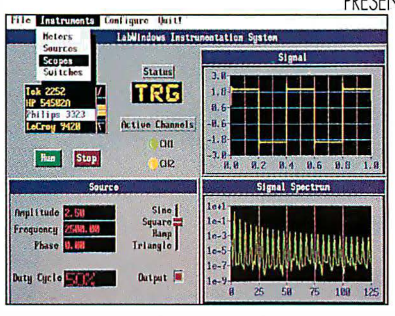


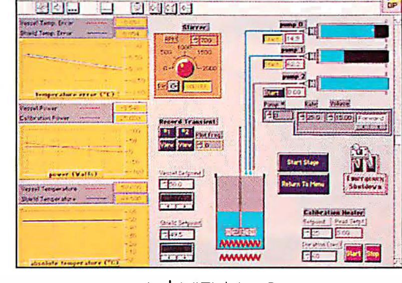
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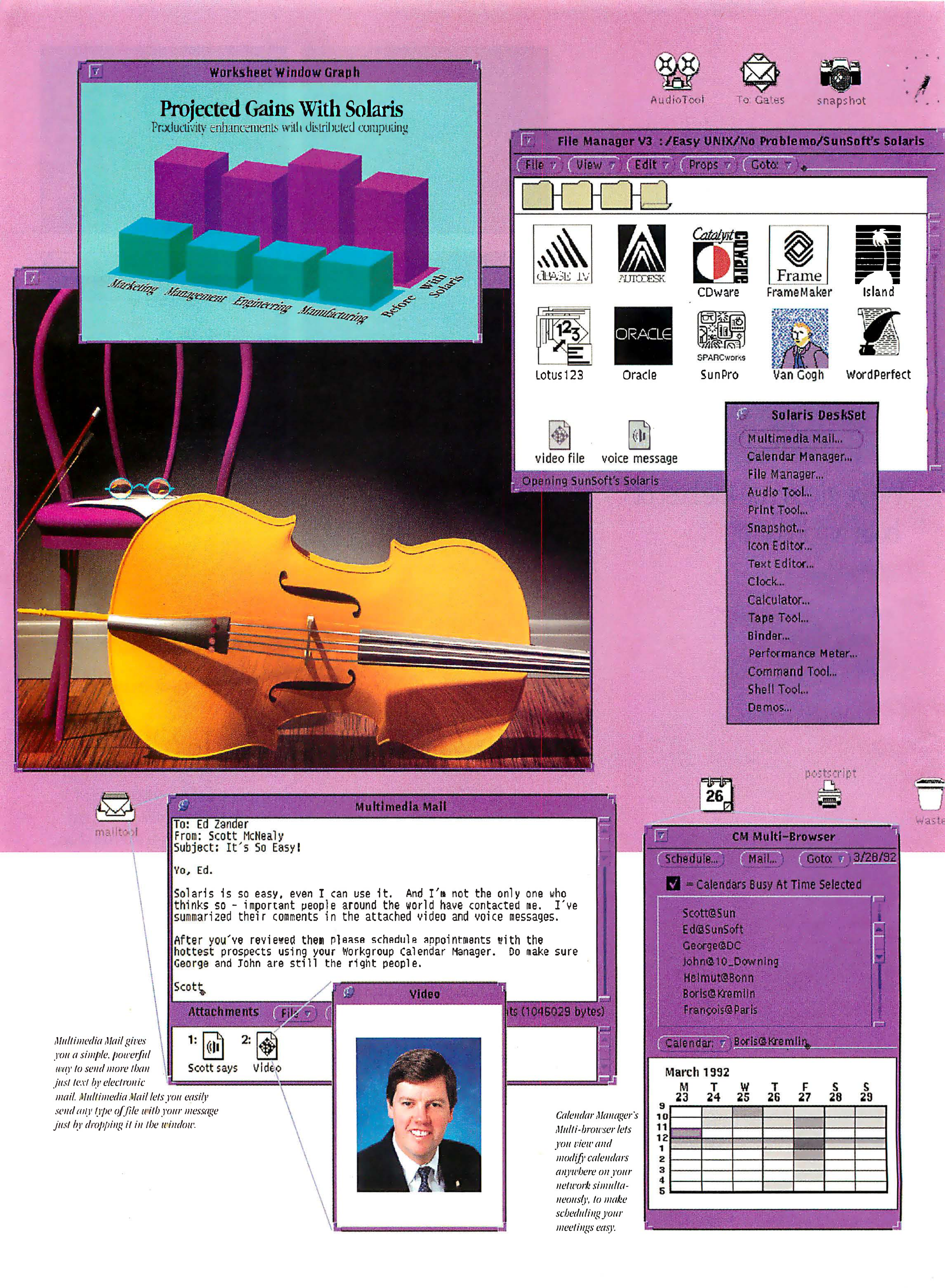
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Multimedia Mail gives you a simple, powerful way to send more than just text by electronic mail. Multimedia Mail lets you easily send any type of file with your message just by dropping it in the window.

Calendar Manager's Multi-browser lets you view and modify calendars anywhere on your network simultaneously, to make scheduling your meetings easy.

Solaris: So Easy It Can't Be UNIX.



Power Made Simple.

Imagine making the power of 32-bit systems easy to use. Imagine networks that not only tie together individuals, they make groups more productive. Imagine computers united by a consistent environment. Imagine running today's favorite programs while gaining access to tomorrow's applications.

Imagine no more. Solaris® system software makes distributed computing as simple as stand-alone computing, while bringing the power of UNIX® and SVR4 to users—easily. Maybe that's why Solaris is the world's most widely used 32-bit computing solution.

The Network At Your Fingertips.

The Solaris solution starts with technology from Xerox that sparked the idea for the Macintosh® user interface, making Solaris as easy to use as any PC. But, because Solaris was created with group productivity in mind, it does much more.

Solaris breaks the isolation of personal computing by bringing network resources to the desktop. Want to send that chart to a color printer in another building? It's easy. Want to render that 3D image on a Cray in the next state? It's easy. Solaris allows objects, like files, to be dragged and dropped on function icons, such as a printer, for instant action. With Solaris, the network is at your fingertips.

Increase Personal And Workgroup Productivity.

Solaris also includes 15 tools that enhance group productivity. Among these is Multimedia Mail, which can send any type of file—applications, audio, video, graphics—in a mail message. The Workgroup Calendar Manager serves as an on-line personal and group calendar that makes scheduling meetings with people next door or on the next continent easy.

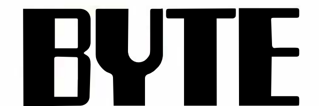
What's more, Solaris offers over 4,000 solutions including Lotus 1-2-3, Ashton-Tate dBase and WordPerfect. And SunSoft has an easy way for you to try these applications. It's Catalyst™ CDware™. With CDware, you can try more than $250,000 of software from your desktop. Solaris offers more options for productive work than any other 32-bit environment. Now, that's easy!

The Time Is Now.

Don't wait for your PC to grow up. It's time to see for yourself how easy it is to access the power of Solaris. Call now for a free version of CDware and the names of our OEM partners who can give you a guided tour of Solaris. 1-800-227-9227, Ext. 123. See you there.



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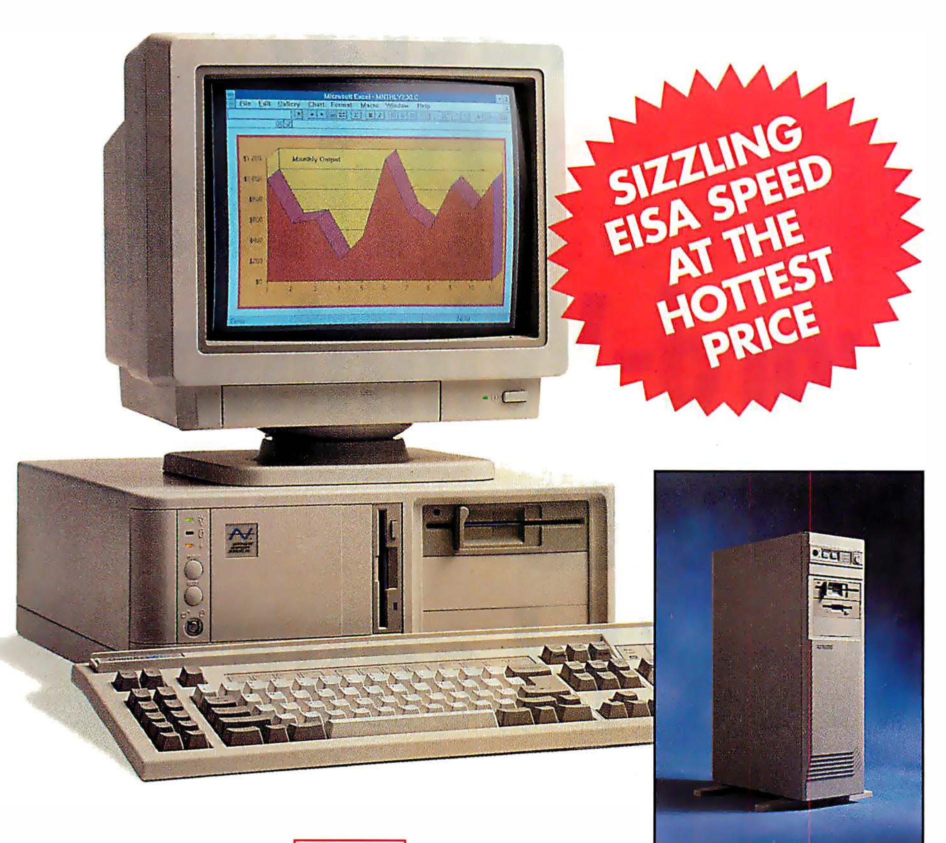
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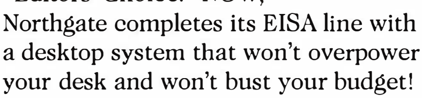
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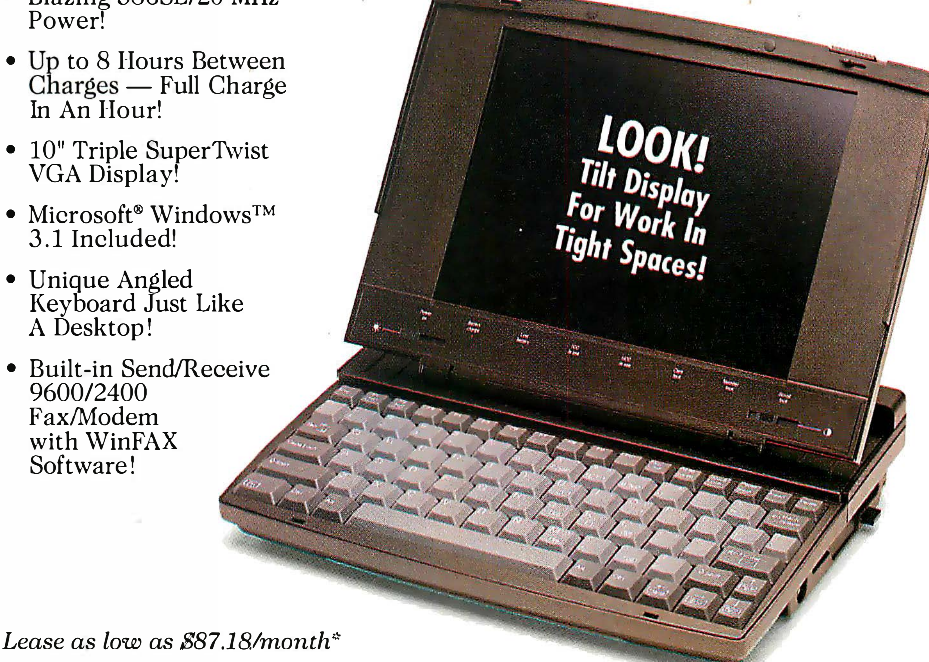
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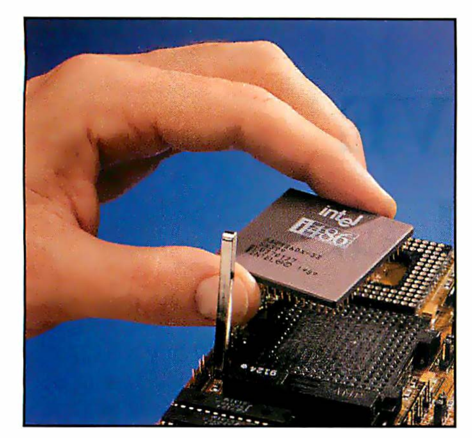
— *PC Magazine, May 26, 1992*

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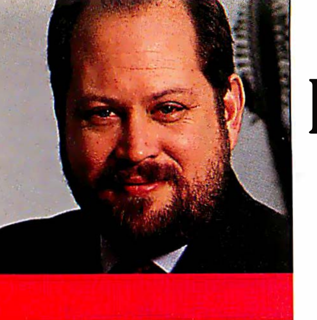


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EDITORIAL

DENNIS ALLEN

A NEW WAVE OF PORTABLES

New types of portable computers will change the way we use computers

There's a new wave of portable computers on its way. If you measure this wave by sheer excitement, Apple's Newton is riding the crest. There's no doubt that Apple has captured the hearts of all who have ever daydreamed about what a computer ought to be. What makes the Newton exciting is that it's a compact, keyboardless approach to computing with intelligent software. Based on the ARM (Advanced RISC machine) microprocessor, it even has the horsepower to accomplish what it's supposed to do. But there's more to the story than just razzle-dazzle.

The Newton represents the beginning of consumer computing. So far, personal computers have not been for the masses, because for most people they're simply too difficult to use. The bad news is that the Newton doesn't solve that problem; the good news is that it takes a gigantic leapt oward that goal. Its multitasking operating system and complex "recognizers" make using the Newton easier than using most other computers.

What makes all this possible is the Newton's customized microprocessor, and that's what is really exciting. Over the next few years, you'll see more and more customizable microprocessors. What this means for hardware designers and software developers is that they can resolve application-specific bottlenecks in silicon by closely coupling certain functions to the CPU.

On the consumer level, customizable microprocessors mean that manufacturers can design a variety of small, dedicated computers. There will be address books, notepads, telephones (yes, telephones), and appointment books that we won't even call "computers." Sure, they'll have a CPU and memory, but they'll be no more programmable than your microwave oven, VCR, and washing machine—all of which have CPUs. You can expect to see several new entries in 1993.

Meanwhile, the rest of us have to do word processing, calculate spreadsheets, and access databases larger than an address book. For us, a more practical solution for now is found in the new portable offerings from Gateway and Dell. Their approach to portable computing is less futuristic and in many ways much more sensible than that of the Newton. Their designs simply exploit DOS-compatible hardware to place it in a more portable package.

Take Gateway's Handbook, for example. In my 15 years of new product demonstrations in the computer industry, I never felt the urge to actually buy a product right then and there until I saw the Handbook. Equally impressive is Dell's new 386SLi, which trades off some of the Handbook's small size and weight for more processing power and a larger keyboard.

No, they don't have handwriting recognition, a multitasking operating system, or software that could automatically send faxes. The Dell and Gateway machines are just computers, and they happen to weigh only half of what most notebooks weigh, come in a more convenient size, and have usable keyboards. They even run my DOS applications software—something the Newton cannot do. You can expect to see similar offerings from other vendors later this year.

Somewhere in between all this is Phoenix's yet-to-be-seen Companion PC. It zeros in on practical computing by embedding into the system traditional applications. For now, though, there are more questions about the Companion PC than there are answers.

So there you have it, a wave of new portable computers, and it's just the beginning. The question is, will it change the way we use computers?

Consider all the times you would have used a computer if it had been a little more portable. Think about all the meetings you've attended in which you would have liked to take notes on your computer, but the keyboard would have been distracting. You'll soon be using a computer in those situations, and that means that you may want to carry different information on your computer than you have in the past.

My advice is to start thinking about how you want that information organized. Decide now what kind of information should be portable and what you want to leave on the desktop or file server. You also need to think about new opportunities afforded by more portable computers for sharing information within your organization.

In other words, let's look beyond the excitement and figure out how to best integrate these new portables into our computing environment.

—Dennis Allen
Editor in Chief
(BIX name "dallen")

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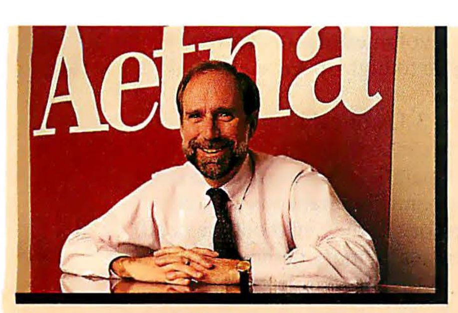
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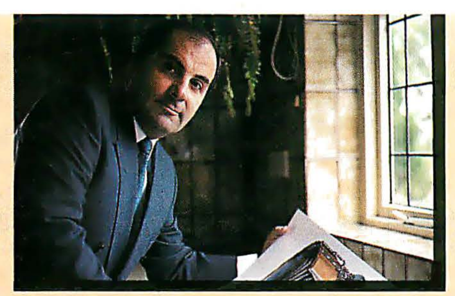
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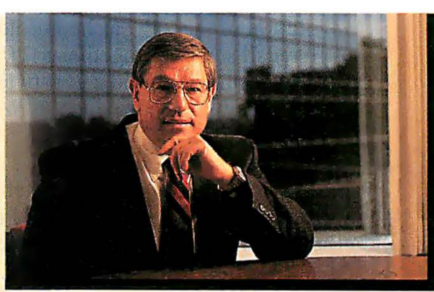
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Tom Jeffery
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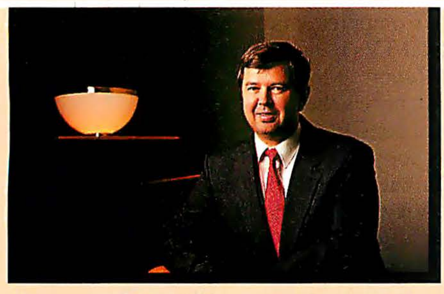
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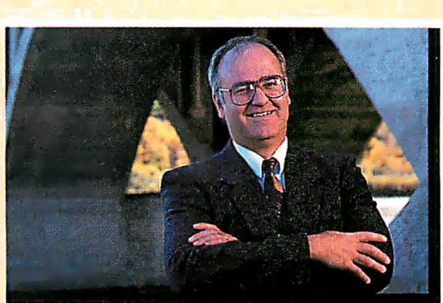
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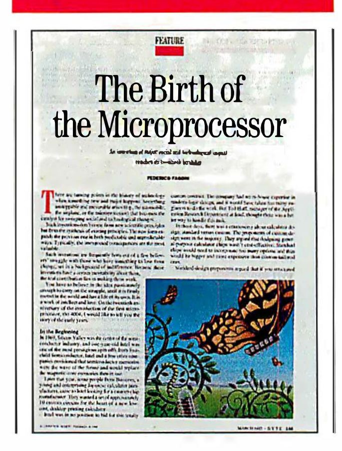
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K. E. Peacock
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LETTERS


FEATURE

The Birth of the Microprocessor

A CPU Is Born

I thoroughly enjoyed Federico Faggin's "The Birth of the Microprocessor" (March). I was able to empathize with the evolution of the CPU as he unfolded it. I still recall scraping together $120 with a buddy of mine to build a 256-byte 8008-based computer as provided in *Radio Electronics* magazine.

I was somewhat bothered by Federico Faggin's innuendo as to the patents obtained by Texas Instruments and Hyatt for their developments. Faggin correctly notes that inventions must be "reduced to practice." However, it is well settled that reduction to practice occurs, by operation of law, upon the filing of a U.S. patent application. Were the law to be otherwise, a lot of enterprising young individuals might be prevented from seeking patent protection because of their inability to invest millions of dollars in completing a prototype. An inventor need only disclose his or her invention sufficiently to facilitate understanding by someone of ordinary skill in the art.

John X. Garred
Fay, Sharpe, Beall, Fagan, Minnich, & McKee
Attorneys at Law
Cleveland, OH

Terabyte Memories

I am writing to correct information in the text box "Terabyte Memories with the Speed of Light" (March, page 168). The device described by Richard Marlon Stein is the Two-Photon 3-D Optical Memory currently under development by Call/Recall. The project is funded by DARPA (Defense Advanced Research Projects Agency) and the USAF (U. S. Air Force).

The technical program manager is Albert Jamberdino, of Rome Laboratory, USAF. Experimental work is being carrried out at the University of California's Irvine and San Diego campuses and at the University of Alabama, Huntsville. The principal investigators on the project are as follows: architecture, Dr. Sadik Esener, UCSD; access lenses, Dr. Stephen Kowel, UAH; materials, Dr. Peter Rentzepis, UCI.

Your readers may be interested to know that, in the recent history of computer development, processor speed has far outpaced access to available memory and has created a serious bottleneck in the development of both large-scale parallel sequential and optically connected stacked-wafer devices.

The 3-D optical memory is an inherently parallel device (i.e., data is accessed in 2-D arrays rather than in a sequential bitstream), and it will realize its ultimate utility with the optical processors currently under development. It will also serve as a high-bandwith page-oriented archival storage and retrieval system for very large volumes of data, currently unavailable to high-speed sequential devices.

And the 3-D optical memory can provide the necessary topological match for a system of parallel sequential processors, which demand simultaneous access to large memory caches, without the need for redundant memory devices. While a memory of the magnitude of that described by Stein will not be available in the near future, it is not unreasonable to expect commercially available 3-D optical memories as an attractive alternative to magnetic tape some time in the next two to three years.

We appreciate your interest in the Computer Memory Project and will be happy to keep your readers informed of the latest developments.

Robert Gold
Program Coordinator
Computer Memory Project
Call/Recall Corp.

BYTE will forward reader inquiries for information on the Computer Memory Project.—Eds.

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FIXES



- The article "Even As We Speak" (April) incorrectly stated that MacinTalk ships with the Macintosh computer. It's available from the Apple Programmers & Developers Association (20525 Mariani Ave., Mail Stop 33G, Cupertino, CA 95014; (408) 562-3910) for $20. The current version is 1.3; ask for part #MM7023.
- In "Roots and Branches of 3-D" (May), Silicon Graphics should have received credit for developing an immediate mode for all GL commands. Also, under the heading "Where We're Headed," a sentence in the fifth paragraph is unclear. It should read: "Computer companies will supply media servers and digital TVs to home clients."
- The BYTE Lab Product Report "Monitors: Beyond VGA" (May) incorrectly identifies the Nanao T-560i monitor with the model number CPD1604S. That number should have applied to the Sony Multiscan HG. In addition, incorrect pricing information made the ViewSonic 7 appear more competitive. ViewSonic 7 has since lowered its price to $1399, the price listed in the features table on page 216.
- The State of the Art Resource Guide (May) contains an incorrect fax number for AT&T Graphics Software Labs. The correct number is (317) 575-0649.
- The new address for The BSE Company, listed in the Items Discussed box of the May User's Column, is 2152 North Fourth St., Flagstaff, AZ 86004. The telephone and fax numbers are, respectively, (602) 527-8843 and (602) 527-1540. ■

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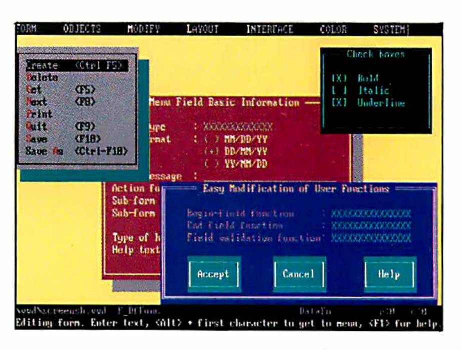
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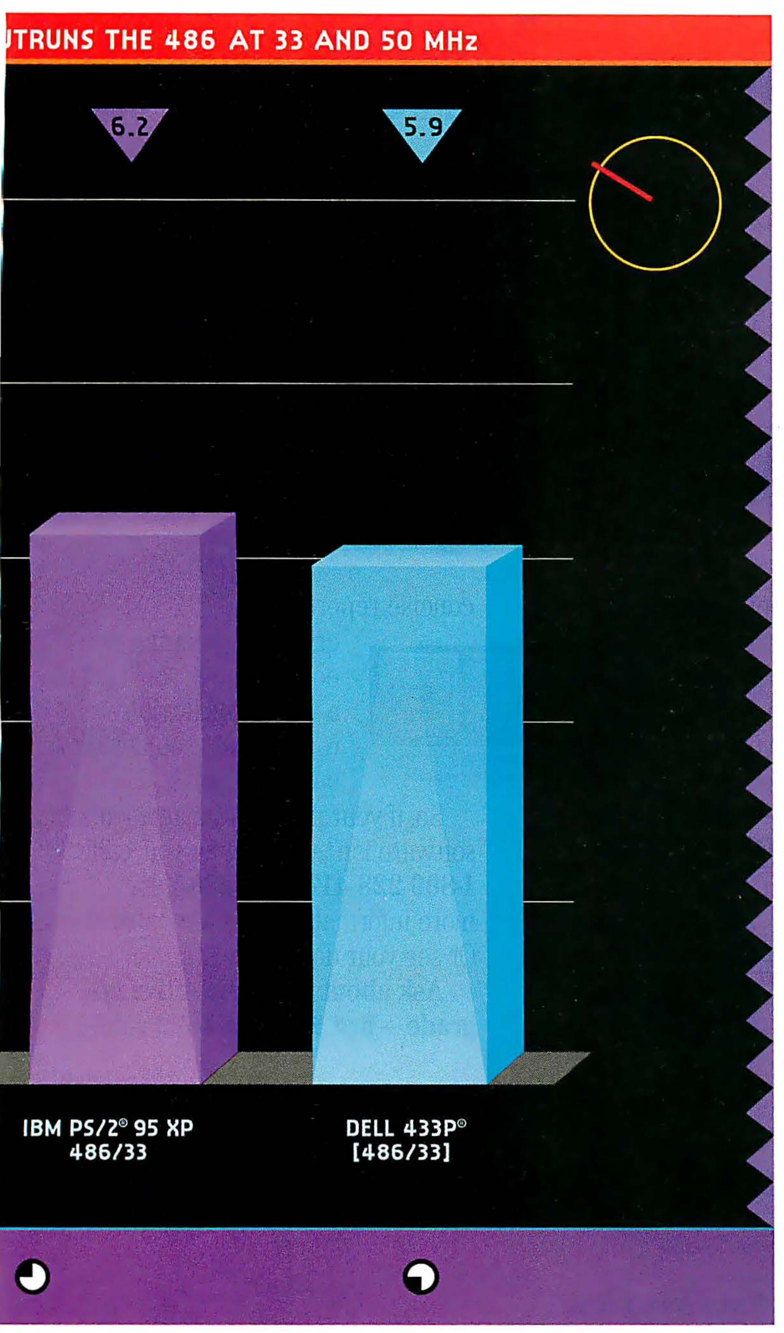
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*Performance Index is the measured result relative to the slowest machine tested (a 286-based IBM PS/1 running Windows). For example, the Macintosh Quadra 950 is 9.7 tim

[1]Ingram Performance Report by Ingram Laboratories, published 3/92. [2]Software programs used in benchmark test were Microsoft® Word,® Excel,® PowerPoint,® Wingz,® PageMaker,® Persuasion® and Illustrator.™

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es faster than the Performance Index; the Dell 433P only 5.9 times faster.

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Let us explain. Ingram Laboratories[1], a leading independent PC testing firm, recently lined up the new Macintosh Quadra™ 700 and 950, powered by 25 MHz and 33 MHz 68040s, and several of the quickest 50 MHz and 33 MHz 486® Windows™ PCs on the market.

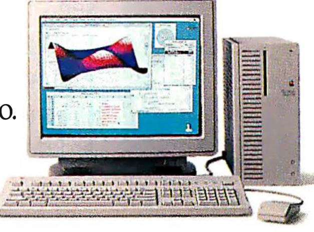
They loaded the computers with the most popular programs available for both Macintosh and Windows 3.0[2]. Then measured the time it took each machine to perform real world functions like opening a file, scrolling, running a macro, performing calculations and so on.

The result? The Macintosh Quadras were 15 to 20 percent faster than the 50 MHz 486 Windows PC. And they blew the 33 MHz 486 boxes right out of the room.

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Windows NT: The Cure for Microsoft's Nightmare?

About this time last year, reports surfaced about a memo from Microsoft chairman and CEO Bill Gates in which he allegedly stated that the "nightmare" of IBM "attacking" the company in systems software and Novell "defeating" Microsoft in networking was not a scenario but a reality. A year later, Windows NT (New Technology), the industrial-strength, 32-bit operating system that should be released to beta testing this month, appears poised to turn the tables.

Windows NT, with its integrated networking, security, portability, and SMP (symmetric multiprocessing), has everyone from Novell to IBM looking over their shoulders. While OS/2 2.0 and Desqview/X are known quantities, it's not clear yet what Univel, the joint venture of USL (Unix Systems Laboratories) and Novell, will bring to the desktop. Reports have said that the company is working on a version of Unix, called Unixware, optimized for the desktop and having seamless NetWare integration. USL officials will say only that the company plans to ship its first version of Unix System V release 4.2 for Intel platforms this summer, offering seamless integration with NetWare 3.x and other environments.

However, at conferences like Spring Comdex 1992, Microsoft has already shown applications such as CorelDraw, AutoCAD, Excel, Word, FrameMaker, Mathematica, and Watcom C/386 running under Windows NT. Many of the applications that Microsoft and other companies have shown are unmodified Windows programs riding on Windows NT's compatible Win32 API. Others have come over from Unix (e.g., GrayTech Software's CAD X11) or OS/2 (e.g., MicroEdge's Slick Editor and Microsoft's Digital Communications Associates/Microsoft Communications Server). Microsoft's ability to show such widespread support among developers that have been using a December 1991 version of Windows NT—a version that predates final code by a full year—is remarkable.

In Windows NT, as in OS/2, the dispatchable unit is the thread rather than, as is the case in most flavors of Unix, the process. Thus, Windows NT's multiprocessor implementations are symmetric, with a fine granularity not yet achieved in SMP implementations of Unix.

Although Windows NT is built around a microkernel, it is no tiny customer, with a minimum recommended allotment of 8 MB of RAM. Windows NT offers immediate advantages, however. It fixes a problem that plagues both Windows' and PM's (Presentation Manager's) handling of input queues. Even though OS/2 is multithreaded, a PM application that doesn't explicitly yield to other applications can hang the system and leave you staring at an hourglass. This is because PM's handling of the system and the applications message queues is, in effect, single-threaded. Windows NT handles the queues separately and prevents any one application from monopolizing the system.

The hardware abstraction layer underneath Windows NT balances the allocation of threads to processors and does so transparently to the Windows NT microkernel, its subsystems, and its applications. To illustrate the point, Microsoft has shown a performance-metering application running on a monster NCR 3550 with eight 50-MHz 486 chips. The metering application showed CPU loads rising and falling evenly across all eight processors as Windows NT loaded and unloaded applications.

The Windows NT executive manages memory, processes, I/O, and security while providing these services to DOS, 16- and 32-bit Windows, OS/2, and Posix subsystems. DOS support takes two forms. On Intel hardware, Windows NT exploits the V86 mode of the 386/486, much as OS/2 2.0 and other Intel-based DOS multitaskers do. On Mips Computer Systems hardware, Microsoft uses a version of

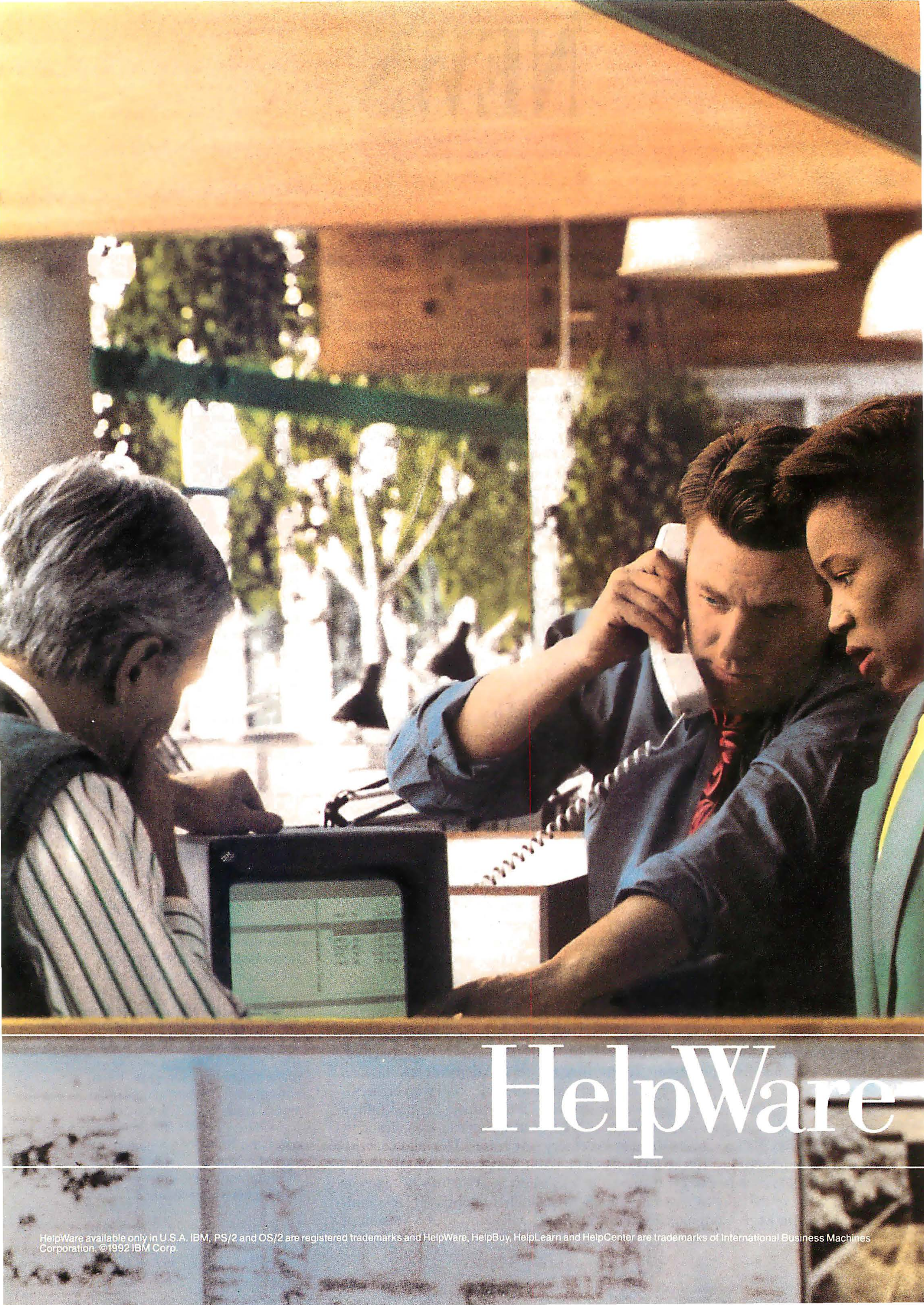
NANOBYTES

Autodesk has named **Carol Bartz** as its new president, chairwoman, and CEO, replacing Alvar Green, who announced his intention to resign as CEO last October. Bartz had been the head of worldwide field operations for Sun Microsystems; thus, she becomes one of the only women other than a founder to head a Silicon Valley public company. "It's a big responsibility," said Bartz. "Women need strong role models, and I have a daughter that I'd like to provide that for." On her management style, Bartz said, "I'm not coming in as a dictator, but I'm not a consensus manager. I don't believe in group decisions. I'm closer to the dictator model." Autodesk founder John Walker, who had criticized the company's current management, said, "With Carol Bartz at the helm, my concerns are laid to rest." □



Sources report that **Microsoft** is working on an upgrade to Windows 3.1 that will add a mail interface (or even a full-fledged E-mail program), which will handle intelligent routing of electronic forms on a LAN, and offer improved networking support. □

Will ACE (Advanced Computing Environment) go down in history as one of those "too-good-to-be-true" ideas? **Compaq** says its plans are on hold for RISC-based commercial systems and has resigned from ACE. Compaq cofounded ACE with 20 other computer and software companies as part of a strategy to move out of the commodity PC business and into higher-end systems. □



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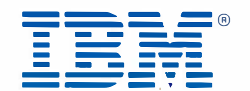
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Circle 54 on Inquiry Card.

Insignia's SoftPC, which emulates a 286. In either case, services requested through INT 21h (e.g., file I/O and memory allocation) are supplied by the 32-bit Windows NT executive. In the case of the R4000, the executive runs natively on RISC hardware, so the emulator's burden is lessened.

Windows NT uses a strategy similar to the one it uses to run DOS programs when running 16-bit Windows 3.x binaries on Intel and Mips platforms. Windows NT's model superficially resembles that of OS/2 2.0, as 16-bit Windows 3.x programs multitask cooperatively in a single VDM (virtual DOS machine) that, in turn, multitasks preemptively with respect to other VDMs and Win32 tasks. This arrangement is necessary because Windows 3.x applications expect to share address space.

In the case of the R4000, Insignia's emulator again comes into play. On Mips hardware, 16-bit Windows programs enjoy better performance than DOS programs do. Windows applications spend up to 40 percent of their time in the Windows kernel. Windows NT's emulator detects calls to the Windows kernel and, as with DOS INT 21h, vectors them through to the Windows NT executive, where the requested services execute natively. Windows NT achieves a seamless mixture of 16-bit Windows 3.x and Win32 applications with less effort than OS/2 2.0 does with Windows and PM applications. This is because Windows NT doesn't need to reconcile differences between Windows' GDI (Graphics Device Interface) and PM's GPI (Graphics Programming Interface).

In terms of networking, every Windows NT machine has roughly the network capability of a LAN Manager peer server: It can mount remote drives, use remote printers, and share its own drives and printers. Like LAN Manager 2.1, Windows NT provides NetBEUI, TCP/IP, and DLC 802.2 transports. Console commands like `net use` and `net share` come standard with the system. File Manager also includes a subset of the LAN Manager Net Admin screen.

Windows NT will provide three models for network interprocess communications: named pipes over NetBIOS, TCP/IP sockets, and OSF/DCE (Open Software Foundation/Distributed Computing Environment) remote-procedure calls. TCP/IP vendors have been working with Microsoft to develop a standard socket API for Windows, called WinSocket, which should be in place by the time Windows NT ships.

In April, Microsoft showed for the first time Windows NT's OS/2 subsystem. While Windows NT does not support OS/2's PM, it does support the OS/2 1.x kernel APIs and thus can run OS/2 character-mode applications. Microsoft showed Windows NT running the OS/2 version of Brief and, startlingly, SQL Server. Windows NT's OS/2 subsystem, which will be supported on Intel hardware only, is an interesting touch. Microsoft may well port SQL Server to Windows NT by the time Windows NT ships. However, much of OS/2's success has been with server-class applications. Windows NT's ability to run those applications in SMP environments could prove strategic.

—Jon Udell

Apple Dealt a Blow in Copyright Suit

Apple suffered a major setback in its copyright lawsuit against Microsoft and Hewlett-Packard when U.S. District Judge Vaughn Walker ruled in April that most of the Mac's on-screen icons are not protected by copyright. Walker said that in each case except the Mac's Trashcan, the icons were either too generic to be copyrighted or were derived from earlier works. The bench ruling, if it remains intact when issued in written form, effectively guts Apple's infringement claims against Windows and NewWave. That's a big if, however: In mid-May, Judge Walker agreed to reconsider his ruling after Apple filed a detailed appeal on the ruling.

From the beginning, Apple argued that the Mac and Windows had to be compared as a whole, while Microsoft argued that individual elements had to be considered for similarity or differences. Unfortunately for Apple, cases in the Ninth Circuit have tended to cut back on expansive copyright protection for computer programs, said Douglas Derwin, a lawyer who has worked on similar cases as a partner in the law firm of Skjerven, Morrill, Mac-Pherson, Franklin & Friel in San Jose, California.

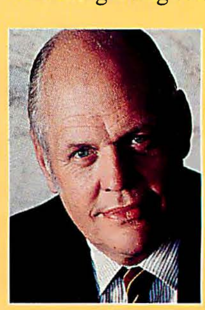
In his decision, Judge Walker cited the most recent such case decided by the Ninth Circuit appeals court, *Brown Bag Software* v. *Symantec*. In that case, the court "rejected the argument that you can see similarity by just looking at the whole thing. You have to subtract out the parts that aren't protected by copyright," Derwin said.

—Harry Doakes

NANOBYTES

After months of near commitment, **Microsoft** and **DEC** have announced that Windows NT (New Technology) will be ported to the Alpha platform. Microsoft is also planning to port its leading Windows applications to the new DEC RISC architecture, while DEC will port its middleware (e.g., networking and E-mail applications) to Windows NT.

DEC is trying to steer a course between maintaining its huge installed base of VAX customers while migrating to the world of—get ready for this—open systems. The potential power of Alpha seems to have taken competitors such as IBM and Sun Microsystems by surprise, but DEC seems anxious to reassure its user base that it won't be left in the lurch. At DECWorld '92, messages concerning the preservation of VAX "legacy" applications and data, support for users, and ease of migration from VAX to Alpha were paramount. "The definition of openness is that it meets the standards," DEC president **Ken Olsen** said. "The test of openness is how easy it is to move applications." □



IBM, **Motorola**, and **Apple** have formally dedicated a facility in Austin, Texas, that will serve as the focal point of design and development efforts for the PowerPC family of single-chip RISC microprocessors. □

Toshiba of Japan is close to an agreement with IBM and Apple to jointly develop a multimedia computer. The first box will be a terminal for personal use that will provide travel guides, traffic information, and educational programs with sound and moving pictures, according to the report. □

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Fox Software, *David Fulton, President:* "FoxPro 2.0 itself is written in WATCOM C, and takes advantage of its many superior features. Optimizing for either speed or compactness is not uncommon, but to accomplish both was quite remarkable."

GO, *Robert Carr, Vice President of Software:* "After looking at the 32-bit Intel 80x86 tools available in the industry, WATCOM C was the best choice. Key factors in our decision were performance, functionality, reliability and technical support."

IBM, *John Soyring, Director of OS/2 Software Developer Programs:* "IBM and WATCOM are working together closely to integrate these compilers with the OS/2 2.0 Programmer's Workbench."

Lotus, *David Reed, Chief Scientist and Vice President, Pen-Based Applications:* "In new product development we're working with WATCOM C because of superior code optimization, responsive support, and timely delivery of technologies important to us like p-code and support for GO Corp's. PenPoint."

Novell, *Nancy Woodward, V.P. and G.M., Development Products:* "We searched the industry for the best 386 C compiler technology to incorporate with our developer toolkits. Our choice was WATCOM."













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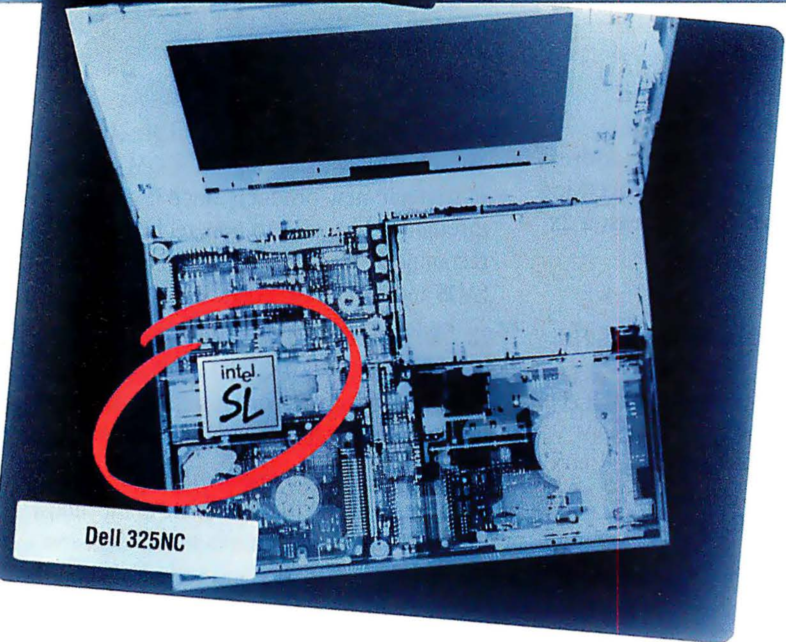
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MICROBYTES

Silicon Storage Gets Competitive

For years, purveyors of memory chips have said that the cost of silicon storage would eventually equal that of rotating magnetic media. Drive makers and analysts scoffed at this prediction, but Intel has taken a big step toward realizing this dream by announcing a new generation of flash-memory chips and cards priced dramatically lower than earlier products. Flash memory, a type of EPROM that retains its data without a power source, operates at speeds like those seen with DRAM chips rather than with magnetic media and holds executable file code.

The 28F008SA chip, which holds 8 Mb (or 1 MB) will sell for less than $30 each in quantities of 10,000. Enough of these tiny chips can be squeezed onto a credit-card-size device to hold 20 MB of stored data, for a raw cost of only $600. This is a far cry from the $250 to $500 cards that held 512 KB or 1 MB only a few years ago.

While drive makers are pioneering new ultratiny drives that still cost less than Intel flash-memory cards, the price differential has suddenly narrowed considerably.

As before, the chips use 5 V for reads and 12 V for writes, but Intel will also offer a slower version that uses only 3.3 V for reads. (AMD is also expected to begin volume production this summer of a new flash-memory chip that needs only 5 V to read and write.) Besides selling the chips, Intel is also selling flash-memory cards with capacities of 4, 10, and 20 MB for $163.50, $331.50, and $611.50 each, respectively, in quantities of 1000. They conform to the PCMCIA 2.0 standard and Intel's ExCA (Exchangeable Card Architecture) and use Microsoft's Flash File System to emulate a drive. Intel is working with Conner Peripherals to create an IDE-compatible solid-state disk that can be plugged into a system, just as if it were a hard drive.

—**Owen Linderholm**

HP Delivers Matchbox-Size Hard Drive

Just when you're getting used to magnetic hard drives that are the size of a card deck, along comes one that's the size of a matchbox. Hewlett-Packard has announced a 1.3-inch magnetic storage device; its drive components are too small to be manufactured like a standard hard drive, so the company has called on watchmaker Citizen to manufacture it. Called the Kittyhawk, the drive can store about 21 MB of data and withstand shocks of 100 g, or the equivalent of a 3-foot fall onto concrete, when operating. HP claims the device can withstand shocks of 225 g while not operating.

HP began development of the Kittyhawk last August and expects to be in mass production of the drive by this August. The company achieved this rapid time to market by cooperating with companies like AT&T Microelectronics, which helped design and manufacture the controller chips. In fact, HP's engineers worked closely with AT&T's to reduce the number of control chips in the hard drive to just seven.

HP chose to use glass as the medium for the disk. The company says that the glass it uses is stronger than the conventional aluminum-substrate medium and is also smoother. The drive can connect to devices through either an AT or a PCMCIA interface and offers an 18-ms average seek time. HP will sell the drive, which will cost about $210 each in quantities of 1000, to manufacturers who will use it in computing devices or in removable configurations.

—**D. L. Andrews**

IBM Sanctions Cellular Data

IBM and nine cellular service carriers—including McCaw Cellular Communications, GTE Mobile Communications, and several regional Bell operating companies—have announced an agreement whereby they will put aside their competitive differences long enough to establish a standard means of transmitting packetized fax and data across cellular networks.

Sending data via cellular networks, which are used today mostly for voice communication, isn't a revolutionary concept. Several companies, including Telebit and Microcom, already produce cellular modems. But these modems are circuit-switched and suffer from the often poor quality of cellular channels. To accommodate cell-switching and "drop-outs," cellular modems have required sophisticated error correction, which has tended

NANOBYTES

Link Technologies (Fremont, CA), a supplier of general-purpose terminals, and **Visual** (Westborough, MA), the X Window System pioneer that delivered the first X terminal, are joining forces to develop a new line of X terminals targeted for manufacturers, distributors, and VARs (value-added resellers). The X terminal line will feature four models, including monochrome and color, at prices below $1000. The terminals will be available this summer. □

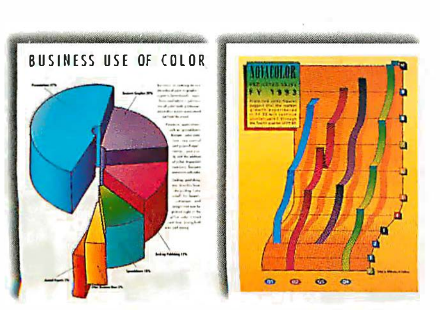
Mark Williams Co. (Northbrook, IL), which says it has already sold over 40,000 copies of its lean, mean Unix-compatible Coherent 3.2 operating system, has broken the 64-KB barrier with its 32-bit version. Designed for small-business and individual use, Coherent 4.0 runs COFF binaries that run on other systems like SCO Unix System V/386 3.2.2. Included are development tools, text-processing utilities, and communications. The operating system requires just 10 MB of memory on your hard drive, runs on 386 and 486 PCs, and costs $99.95. □

Want to test the pen-based computing market but don't want to invest in an expensive pen system? **Arthur Dent** (Tewksbury, MA), a start-up of former Wang Laboratories employees, has developed WriteAway, a transparent digitizer add-on kit that transforms a notebook into a pen convertible. The first version of the $595 kit supports the Zeos Notebook 386+. □

Kala, a transactional store and persistent data management engine for Sun-3s and Sparcstations running SunOS, is being ported to DOS and Windows, its developer reports. Developer Sergiu Simmel (Arlington, MA) reports that the engine is suitable for C and C++ developers who are writing document management, hypermedia, groupware, and image-processing applications. □

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to make them expensive and bulky.

The announcement by Big Blue and the nine carriers addresses these problems by defining a protocol for packetizing data over cellular services, which could lead to a new generation of smaller and less expensive cellular modems, as well as improved service for customers. By agreeing to a common standard, the highly competitive carriers will also let users more easily "roam" among different cellular systems, maintaining communication.

According to the companies, as much as 40 percent of existing cellular bandwidth is now unused and held in reserve for anticipated future needs. When implemented, the new scheme will use this excess capacity: Special frequency-agile controllers at regional cells will locate an unused frequency and send or receive hundreds of data packets per second. When the frequency is needed for a voice call, the controller will hop to another channel instantly, the companies say. This scheme reportedly works with no loss of data packets or interference with voice traffic.

IBM may have won the manufacturing end of the deal due to its work on the IBM Information Network, which gave it expertise in X.25 packet-switching. IBM's contribution, called CelluPlan II, entails putting together the prototype components needed for carriers to upgrade their cells to handle data-packet assembly and disassembly.

One part of the plan that remains undetermined is pricing. Cellular callers are billed by the connection-minute, but an E-mail transmission at 19,200 bps could take only a few seconds. The carriers involved say that packet-switching technology will let them bill in shorter increments of time appropriate to customer needs.

A potential obstacle to the plan is transmitting faxes and E-mail through heavy-use areas where idle voice channels are few and far between. The companies forming CelluPlan II say that they will cross that bridge when they get to it.

The plan to use cellular networks for packet data represents a challenge to two existing wide-area wireless communications services, Ardis (a joint venture of Motorola and IBM) and RAM Mobile Data. Both companies now offer mobile communication across data-only packet-radio networks; the services aren't especially fast, but until now, they have offered higher reliability and lower cost than those of cellular modems. When asked to comment on the cooperative cellular announcement, an Ardis spokesperson said that it will make people more aware of the value of packetized data communications. This may be true, but it will also permit users to choose a single carrier for both voice and data, rather than two separate companies.

Jack Blumenstein, president of Ardis, says that CelluPlan II uses a coding system that consumes about half its effective throughput, reducing its transmission rate to an effective 9600-bps transmission. Ardis will offer about 14,000-bps effective throughput on its protocol when the company begins installing its 19,200-bps network this summer, with the first installations scheduled for Washington, D.C. "It could be years before there is a robust offering out there," he said of CelluPlan II. "But I see us [Ardis] interconnecting to a number of networks, including CelluPlan II, if and when it emerges."

If the CelluPlan II technology is embraced by the general public, the cellular carriers could gain a substantial role in the brave new world of personal digital electronics.

—Ed Perratore

Palmtop-on-a-Chip: Just Add Memory

Vadem (San Jose, CA), a small computer chip-set designer, has introduced a single-chip, palmtop "PC-on-a chip" design that computer manufacturers can use to quickly bring small, inexpensive palmtops to market.

Vadem says the VG-230 Sub-Notebook Engine is the first single-chip PC platform for portable computers that supports the latest industry standard for memory cards and miniature peripherals. The VG-230 Sub-Notebook Engine will let computer OEMs rapidly develop the new class of personal digital appliances for the consumer-electronics industry.

Vadem's chip design incorporates an 8086-compatible 16-MHz NEC V30HL microprocessor into a single-chip device that holds all the core logic required to build a battery-powered, IBM-compatible hand-held computer.

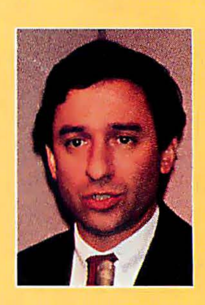
In a half-dollar-size package, the VG-230 Sub-Notebook Engine contains the V30HL processor integrated with an LCD controller, which supports the CGA as well as 400-line AT&T text and graphics standards, an internal keyboard scanner, and a built-in power management unit. ■

—Patrick Waurzyniak

NANOBYTES

In a further sign of consolidation within the PC database market, software giant CA (Computer Associates) will acquire **Nantucket**, one of the leading developers of dBase-compatible databases. CA says development will continue on Nantucket's Windows version of Clipper, which is code-named "Aspen." With Microsoft's acquisition of Fox Software, the move leaves WordTech as the only major dBase-compatible developer still independent. □

Lotus Development officials continue to insist that its strategy regarding databases is one of connectivity, not acquisitions. **Jim Manzi**, Lotus's chairman, president, and CEO, recently told analysts that the company's research indicates that the lowest growth potential for PCs is in the relational database market. Manzi also told BYTE that while rival Microsoft seemed determined to get a database product one way or another, Lotus's strategy is one of connectivity when it comes to the RDBMS (relational database management system) market. Stay tuned.... □



Ad Lib, the Quebec-based developer of multimedia audio cards, is restructuring under receivership. At press time, it was unclear if the company would release its Gold 1000 Stereo Sound Adapter (see "The Sound of Gold," May BYTE, page 58). □

After announcing its NB-SL/25C color notebook, **Epson** has discontinued it due to quality issues associated with its new metal-insulator-metal LCD screen (see Microbytes, December 1991 BYTE, page 42). The company says it will still offer the monochrome version. ■

32 Reasons Why Zortech Is A Better C++ Than Microsoft Or Borland.

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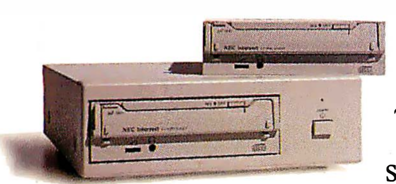
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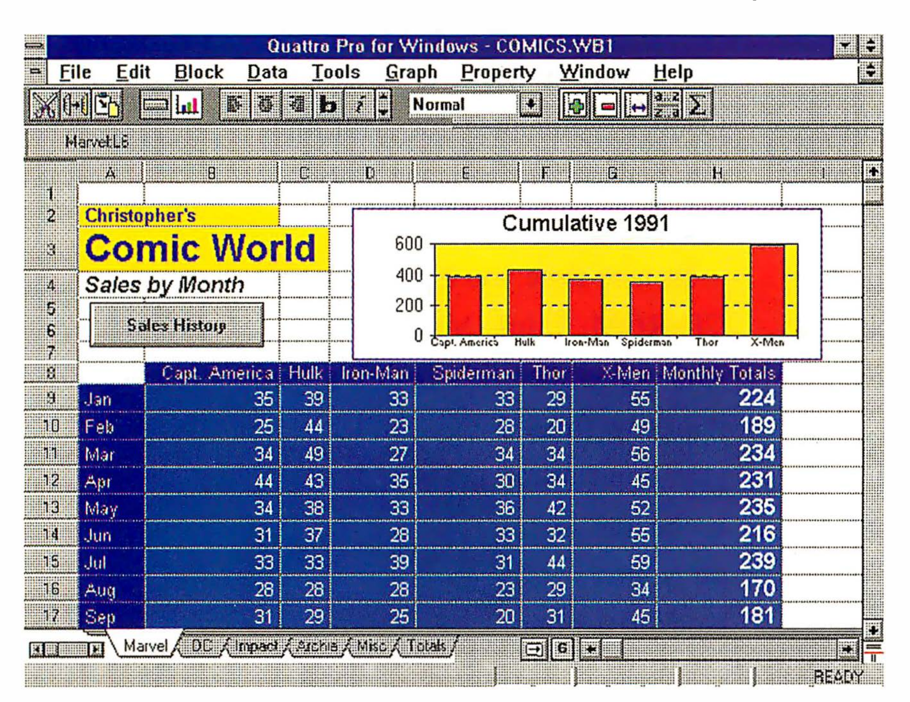
Battle of the Super Spreadsheets

KENNETH M. SHELDON

Quattro Pro for Windows takes on Excel 4.0 for the title of king of the Windows spreadsheet mountain

Hot on the heels of Microsoft's recent announcement of Excel 4.0 for Windows, Borland has released the first Windows version of its Quattro Pro spreadsheet. Both programs aim to provide new, more powerful features, while making those features easier to use—no small task, given the sheer number of features these programs provide. After evaluating the shipping version of Excel and a prerelease copy of Quattro Pro for Windows, I found that each succeeds in some areas and falls short in others.

For the past year, Microsoft has been investing much time and effort in its Usability Lab, watching novice users wrestle with programs and making changes based on what it sees. Meanwhile, Borland has been emphasizing an object-oriented design approach for all its new programs.



Screen 1: *In Quattro Pro for Windows, spreadsheets are organized into Notebooks, with labeled tabs that let you easily manipulate and consolidate your data. This example shows Quattro Pro's SpeedBar, a user-defined Power Button, and formatting that was done using the SpeedBar.*

The result? Two programs that, while different on the surface, share many features. In fact, just about anything you can do with one of these programs, you can do with the other. It may not be as *easy*, but you can usually do it. Both programs make trade-offs between the vast number of features available and making those features easy for you to understand and use.

Step Up to the Bar

Both Quattro Pro for Windows and Excel 4.0 have a push-button menu bar along the top that lets you perform routine tasks (e.g., cutting and pasting and summing). Quattro Pro's SpeedBar (see screen 1) and Excel's Toolbar (see screen 2) are remarkably similar, although each has some buttons the other lacks.

The bar changes depending on what task you're performing. Both programs let you move and resize these bars, and Excel automatically rearranges the buttons when you do. (Borland says Quattro Pro will have this feature by the time it's released.) Also, if you drag a Toolbar to the top, bottom, or side of the screen, Excel snaps it neatly into place there.

You can create new Toolbars and SpeedBars. That process is much easier in Excel 4.0 than in Quattro Pro, and there's another major advantage: Excel lets you change the standard Toolbars. (Borland says that the shipping version of Quattro Pro will also provide this feature.) You don't like the choice of buttons or their arrangement? Excel lets you remove buttons that you don't use, add buttons from other toolbars, rearrange buttons, or create your own tools. For example, Quattro Pro's SpeedBar provides a handy Best Fit button that automatically changes the width of a column to fit the longest entry in it. Excel doesn't have such a button, but I was able to quickly create one and add it to the standard Toolbar in a matter of minutes.

The Quattro Pro SpeedBar also features a Power Button tool. If you click on it, you can add buttons directly to your spreadsheet, which you can then use to run macros automatically. Excel has a Button tool that does the same thing, but it's hidden away on a Utility toolbar. Again, though, you can easily add this tool to the standard Toolbar if you like.

Such a Drag

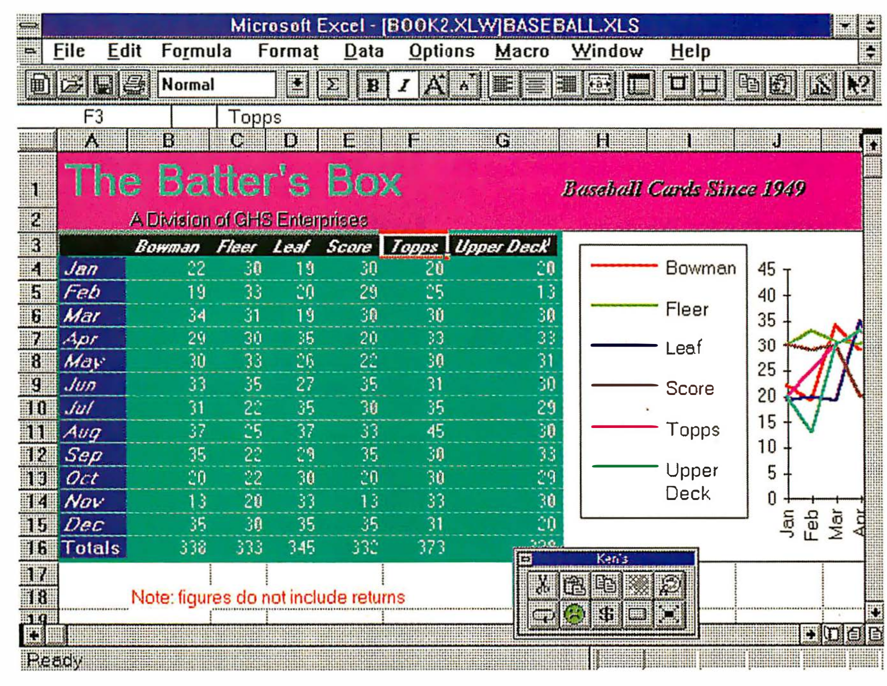
Another feature shared by these programs is the ability to drag and drop spreadsheet

cells. You select an area with the mouse and drag it to a new location (or hold down the Control key to copy it). This is a useful feature, but each program has its quirks. Quattro Pro doesn't let you drag and drop single cells; Excel makes you point to the highlighted edge of the selected block, which takes a little practice. (That may be a feature, though; several times while using Quattro Pro, I inadvertently moved a block that I had previously selected.)

Beyond that, Excel has a few features for entering and manipulating cells that Quattro Pro doesn't. The most interesting of these is AutoFill, which lets you type the first entry in a series and drag the edge of the cell to select more cells; Excel will automatically fill in those cells with the appropriate data.

For example, if you type `January`, Excel will enter `February`, `March`, and so on. Enter `1` in a cell and `3` in the next, and Excel will automatically fill in the remainder of the selected block with a series of odd numbers. You can do the same thing with Quattro Pro, but it's not as automatic; you have to use menus, which isn't nearly as easy or as much fun.

Excel's AutoSelect feature lets you automatically select all the active cells in a row or column. Then there's AutoFormat, a standard Toolbar button that automatically applies one of several predefined formats to the current block of data. Either program will let you do all this using pull-down menus and dialog boxes, but only Excel automates the procedures, which makes them especially easy for novices.



Screen 2: *The Excel 4.0 Toolbar features, among other tools, an AutoFormat button that formatted this worksheet automatically, using a predefined format called "colorful 2." The AutoFill feature created the titles in the month column. Note the custom Toolbar that I designed, which contains tools that I found myself using often.*

3-D: The Next Generation

For all Excel's features, there's one place where Quattro Pro for Windows shines: its organization of multiple spreadsheets. Quattro Pro lets you group related spreadsheets into Notebooks, with tabs for each spreadsheet. You can label the tabs and use them to flip through or rearrange the spreadsheets. More important, you can consolidate the contents of spreadsheets merely by clicking and dragging across tabs.

Excel has a similar, though less intuitive, feature called Workbooks. Each Workbook contains a Contents page from which you can access the bound worksheets, or you can click on icons to cycle through them. The Notebook feature is so simple and natural that you wonder why somebody didn't think of it before.

Quattro Pro's other strength is its Menus on Demand feature: Point to any object on the screen, click the right mouse button, and up pops a menu with selections pertinent to that object—much easier than traversing layers and layers of pull-down menus to perform a task. (You can still use the pull-down menus if you prefer.) Excel provides a similar right-button feature, but it's just not as elegant as Quattro Pro's.

Also, each of Quattro Pro's Menus on Demand features a help button, so you can get context-sensitive help at any time. Excel provides a special help button on its Toolbar; click on it, click on a command or screen object, and you'll get help.

Of course, the best help utility is no substitute for a friendly interface. To this end, Excel provides a few Wizard tools that walk you through common tasks. Click on the ChartWizard button, and Excel will help you create a chart, step by step. While Quattro Pro's SpeedBar has a Graph button that will create a quick column graph for you, it isn't immediately obvious how to change that graph.

Manipulating graphs provides another example of Excel's intuitive interface: It lets you rotate three-dimensional graphs just by clicking on and dragging them. This is especially useful if you discover that one series of elements is hiding the elements behind it. This is a much more direct way to rotate a graph than Quattro Pro's, which makes you go through a pop-up menu, enter viewing angles, and so forth.

Entering Analysis

Once you have your data entered, both programs provide a number of tools to let you analyze it. Quattro Pro offers frequency distributions, regression analysis, matrix operations, and other functions. Excel's Analysis Toolpak provides a number of specialized functions that will appeal to engineers: histograms, Fourier analysis, and so on. Both programs let you perform advanced "what-if" analyses with multiple variables. Each also provides tools that let you examine database information in a variety of ways.

To make this last task simpler, Excel provides ReportWizard, which guides you through the process of cross-tabulating data. Both programs let you perform queries to external databases, and both support DDE links to other applications;

Excel also supports OLE (Object Linking and Embedding) links. I was able to link a portion of a Quattro Pro Notebook to an Excel Workbook, but Quattro Pro wouldn't let me do the same thing in reverse. Note, however, that I was using beta software; this problem will probably be solved by the time Quattro Pro is shipped.

THE FACTS

Quattro Pro for Windows
$495

System requirements:
Windows 3.0 or higher, 4 MB of RAM, and a hard drive with 10 MB of free space; a mouse is recommended.

Borland International, Inc.
P.O. Box 660001
1800 Green Hills Rd.
Scotts Valley, CA 95066
(408) 438-8400
fax: (408) 438-0839
Circle 1217 on Inquiry Card.

Excel 4.0 for Windows
$495

System requirements:
Windows 3.0 or higher, 2 MB of RAM, and a hard drive with 8 MB of free space; a mouse is recommended.

Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(800) 426-9400
(206) 882-8080
fax: (206) 936-7329
Circle 1218 on Inquiry Card.

Two Super Spreadsheets

When Superman was created, he couldn't fly. Soon a challenger superhero appeared: Captain Marvel, who *could* fly. Superman suddenly learned how to fly, and a legal dispute led Captain Marvel into early retirement. Today, no one remembers when Superman couldn't fly.

Comparing Excel 4.0 and Quattro Pro for Windows is a bit like deciding whether Superman or Captain Marvel is more powerful. These are both extremely powerful programs, and neither one is through adding features. Excel is still the Superman of spreadsheets, but Quattro Pro's features—especially its Notebook method of organizing and connecting multiple spreadsheets—make it a worthy challenger, one that will undoubtedly become more powerful in future releases. ■

Kenneth M. Sheldon is a consulting editor for BYTE. He can be reached on BIX as "ksheldon."

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First of the Red-Hot R4000s

BEN SMITH

Silicon Graphics' Crimson lights the flame for the R4000 processor from Mips

The Iris Crimson is more than a color change for midrange Unix-based graphics workstations from SGI (Silicon Graphics, Inc.). I got an early look at the Crimson, which is the first system with the new 64-bit R4000SC RISC processor from Mips Computer Systems. The Crimson also sports the highly configurable graphics engine, Elan. Even though the basic machine costs three times more than an Intel-based workstation, it has eight times the performance. But most important, the R4000-based Crimson is the first of a new generation of SGI computers.

There is a world of difference between Unix-based and PC-based workstations. The most notable difference is in computational capabilities. Even though both categories may be single-seat computing craft, Unix machines feel like jet fighters, and PCs feel like small (and safe) single-engine private aircraft. The Iris Crimson is the F-15, scorchingly fast and highly sophisticated. When it's configured without any graphics processors, you can use it as a workhorse file and compute server, but would you want to strip out an F-15 so that you could use it to haul cattle?

Running a Crimson with the Elan board gives me the feeling that I'm three-dimensional graphics combat ready. I feel invincible with the Crimson/VGXT that I looked at. Despite all this power and the fact that I'm running Unix, this is a comfortable world. SGI's System V release 3.0 Unix (Irix) now uses a GUI based on X Window System and Motif that makes other GUIs (with the exception of Hewlett-Packard's VUE) look like cold fish. There is still much of the look of the old News-based Irix user interface, but this is trim and fast. Also, it doesn't require you to write in Display PostScript to make modifications to your menus.



The Iris Crimson introduces the R4000 processor from Mips Computer Systems and Silicon Graphics' Elan graphics card.

Processing Power

SGI is the first computer manufacturer to actually get an R4000-based computer out the door. As a result of the merger of Mips and SGI, it may also be the only one that succeeds with this significantly different RISC processor. Now the company controls its own future by controlling the design of its CPUs.

The R4000 is significantly different from the R3000 (the CPU in the rest of SGI's workstations) because it is a full 64-bit processor and uses superpipelining—an internal clock cycle that is twice as fast as what the rest of the circuitry sees. On the Crimson, the CPU appears to the bus as a 50-MHz (the external clock speed) chip, but internally it's cranking at 100 MHz. Superpipelining allows faster CPU processing while maintaining a clock speed that memory and other devices can easily live with. Because the R4000 will run the 32-bit R3000 binaries without modification, a performance gain is achieved even without recompiling.

The R4000 can be viewed as having three major logical units integrated on the same chip: the integer execution unit, the FPU, and the MMU (memory management unit). To produce even more processing throughput, the Iris Crimson uses the SC model of the R4000 processor, which means that it supports secondary data caching. There are 8 KB of instruction-cache memory and 8 KB of data-cache memory integrated on the R4000. The Crimson has 1 MB of secondary-cache memory (external from the CPU chip), which communicates with the R4000 over a 128-bit-wide interface. (The R4000SC chip has 447 pins.) Both the primary and secondary caches are write-back. This all means that the superpipelining is more likely to work at its full capacity.

It's likely that the R4000 processor will soon be the core of all computers from

SGI. Because R3000 code will run on the R4000 without modification and with some significant improvement in performance, this is an easy upgrade. The real performance gains for programs that use large data sets will be realized as the applications and operating system use the full 64-bit characteristics of the R4000.

More Than Just the CPU

SGI manages to wring more performance from Mips processors than anyone else because of the work the company put into taking full advantage of every aspect of the CPU. The Crimson design has managed to maintain high performance while keeping manufacturing costs low as a result of SGI's proprietary ASIC (application-specific IC) designs: an R4000SC–to–Crimson bus interface ASIC, an R4000SC–to–memory interface ASIC, a Crimson bus–to–memory interface ASIC, and four DRAM-control ASICs.

The Iris Crimson is enclosed in the same chassis and backplane as the Iris Power series (26 by 21 by 29 inches), in great contrast to the little Iris Indigo. On the outside, the most obvious attribute is the deep-crimson case. On the inside are four VME-bus slots.

The memory configurations start at 16 MB and can go up to 256 MB of RAM, and from 780 MB to 3.6 GB (gigabytes) of RAM on an internal disk. (For really large data sets, you can use external enclosures to expand to up to 48 GB of disk space—which is one of the advantages of a 64-bit system.)

The unit has four RS-232 ports (expandable to six). There is a thick- or thin-wire Ethernet interface (expandable to three); options include Token Ring, HPPI (High Performance Peripheral Interface), and FDDI (Fiber Distributed Data Interface). Two SCSI channels are standard (up to eight, optionally), with up to four drives per channel. You can also add up to four IPI2 channels (with up to eight drives per channel), a standard IEEE-488 parallel port, and a Centronics parallel port.

I'd want the optional CD-ROM drive to install additional software and system updates, as well as the 8-mm DAT (digital audiotape) for backups. You can configure the Crimson as a stand-alone workstation or as a server. There is no question that it will replace the Personal Iris (with a Mips R3000 processor) series. It is priced in the same range but offers more options and a greater range of configurations.

Elan Graphics Board

You can configure the Crimson without a graphics coprocessor (3-D graphics is done in software) or, for the very highest performance, with the high-end VGXT graphics system. Without a graphics board, the Crimson/Server makes a good file server at a base price of $27,900.

The Crimson/Entry ($29,900) will give you an impressive 375,000 3-D vectors per second, 80,000 3-D polygons (flat-shaded, unlit triangles) per second, 8-bit color, and z-buffering in software. (For comparison, the $28,000 Turbo Graphics Personal Iris/35 yields only 219,000 3-D vectors per second, but it does give 52,000 3-D polygons per second.)

SGI is now shipping its important new graphics processor, the Elan, for everything from the Indigo up through the Crimson. Although it's not cheap ($15,000 to $22,000), the Elan board provides tremendous 3-D graphics power, with 24-bit color and z-buffering, four-stencil bit planes, four overlay and four window-clipping ID planes, 1 million vectors per second, and 370,000 3-D polygons per second.

Nearly every important 3-D effect (except ray tracing and radiosity) is done in hardware on the Elan board. At the low end, the board maintains all pixel locations as fractions even though they must be resolved to integers when being displayed. This feature, *subpixel positioning*, prevents jitter during real-time animation and supports the hardware antialiasing for lines and points in motion. The board's weighted blending is useful for antialiasing and also for creating a depth-of-field effect, motion blur, soft shadows, fog, and haze.

The Elan graphics engine generates lighting effects for eight local light sources and will generate Phong lighting effects (i.e., highlights) while smoothing polygon descriptions of smooth surfaces. For either side of a surface, I was able to describe its light emissivity (i.e., glow) and its ambient, diffuse, or specular reflectivity (i.e., shininess), as well as its transparency.

In addition, the hardware will apply texture maps to any surface. I could tell it to apply the texture so that it stayed "stuck" to the surface as the object moved or so that the texture stayed fixed to my viewing position to let surfaces move through it—an effect similar to someone dancing in the image light beam of a slide projector. I could also specify that this texture be applied to an invisible sphere surrounding the center of my view of an object. What I saw were the reflections of the texture on the surfaces of my objects—a sort of poor man's ray tracing, but in real time.

The Evaluation Unit

The Crimson/VGXT that I evaluated has 128 MB of RAM and 780 MB of disk space. The price tag is $110,900. This is the most powerful and expensive system that BYTE has ever evaluated.

The VGXT graphics system provides 48-bit color with 24-bit z-buffering, 1 million vectors per second, and 180,000 polygons per second. This is the very high end and represents $72,000 of the total price. (This is the price of real-time photo-realistic 3-D graphics.) When you watch smooth-surfaced buildings and aircraft and solid, texture-mapped mountains roll by in a real-time simulation of flying an F-15, you can truly appreciate this graphics hardware. You can walk through an architectural rendering or dive into the structure of a brain that is being rendered from MRI or CAT-scan data—all in smooth real time.

But even without all the fancy and expensive graphics, the Crimson shows some astonishing results. The Iris Crimson ran BYTE's Unix benchmarks with the highest indexes of any machine we have tested. It had a Double-Precision Floating-Point index of 8.6 and a Dhrystone 2 index of 4.7—that's 104,327 dhrystones per second. The overall average of the six BYTE indexes is 6.3 times that of a Sun Sparcstation IPC, the baseline machine. These results are higher than those for the HP/Apollo 720 (which has an average index of 4.3) and almost as high as the results for the IBM RISC System/6000 950 (an average index of 8.3, which is achieved by very fast file I/O through massive disk caches).

You don't need this kind of processing power for a business workstation, but you surely can use it when you are doing large and complex 3-D data analysis and visualization. And without the graphics-processing boards, the Crimson makes an excellent and affordable department compute server or even a file server.

It Is Important

True, the Iris Crimson is an ideal machine for medical research and data visualization, molecular modeling, remote-sensing data analysis, finite-element analysis, and other computing-intensive applications. But it is even more important as the herald

of future R4000-based systems, from SGI and other vendors.

For SGI, the R4000MP (the multiprocessor version) is logically the processor for a new line that will outperform the company's Power series. In addition, as chip manufacturing improves, simple improvements to the R4000 will greatly increase its already phenomenal performance; the cache sizes can increase, and the processor can be sped up. All this will be under the control of SGI by the end of this year. Competition will come from the RISC System/6000 (IBM's high-end version still has a four-chip set), the HP/Apollo PA-RISC, and DEC's Alpha. SGI holds all three fairly closely, whereas Mips processor designs are licensed to several IC manufacturers and are thus much more available.

The CPU is only part of the story in the world of real-time 3-D graphics systems. SGI continues to reach out with new designs like the Elan board that will spread development costs over its entire line of computers. The excellent engineering and performance of the Iris Crimson and the little Indigo are responsible for SGI's being recognized for more than 3-D graphics workstations. The company is now carving out a piece of the market for general-engineering and office workstations. The merger with Mips has thus ensured SGI's foothold.

My overall impression of SGI's Iris Crimson is that it's a machine for very serious work. The Crimson is sturdy and very fast. As applications are developed for its 64-bit power, it will become known for being not only the first such machine but also one of the finest affordable 64-bit computers. ■

Ben Smith is a BYTE technical editor and the author of UNIX Step-by-Step *(H. W. Sams, 1990). You can contact him on BIX as "bensmith" or on Internet at ben@bytepb.byte.com.*

THE FACTS

Crimson/Entry
$29,900

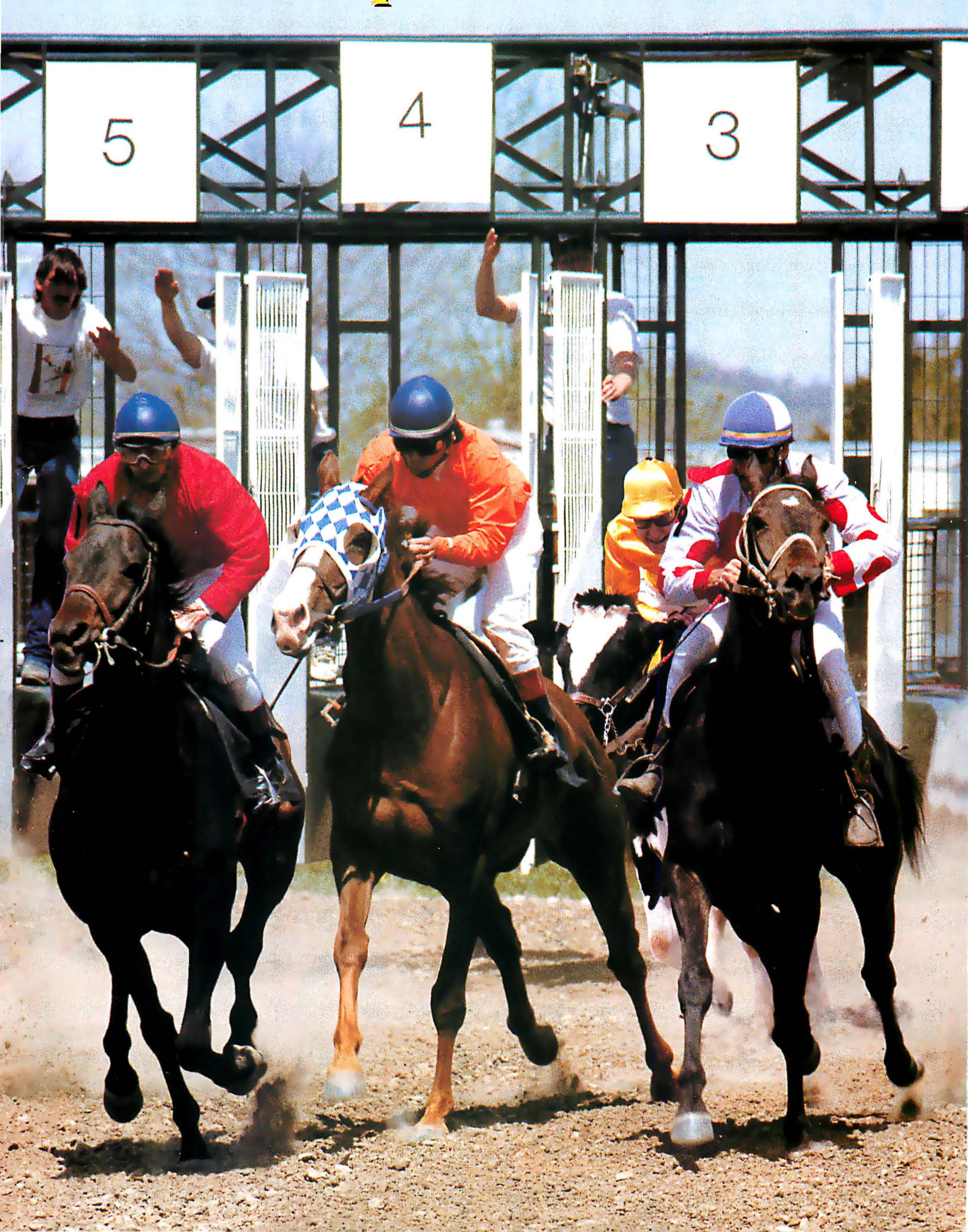
Crimson/Server
with 16 MB of RAM and 3.6 GB of RAM on internal disk, $27,900

Crimson/VGXT
with 128 MB of RAM and 780 MB of disk space, $110,900

Elan
$15,000 to $22,000

Silicon Graphics, Inc.
2011 North Shoreline Blvd.
Mountain View, CA 94043
(415) 960-1980
fax: (415) 961-0595
Circle 1210 on Inquiry Card.

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way 2000
he Winners Circle



Gateway 2000 employees were photographed for the summer fun ad at Atokad Park in South Sioux City, Nebraska.



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Our small, lightweight Nomad notebook computers let you take desktop computer performance anywhere you go. Nomad models come with VGA graphics, a FieldMouse™ (portable pointing device), built-in floppy drive, and an 80 or 120MB hard drive, depending on the model. A patented power-management system gives you hard-to-beat battery life benchmarks — over six hours of operation from a single battery on the 25MHz 486DX system!

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Nomad 325SXL $1995

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Combo Highlights: Nomad 425DXL ■ 15" CrystalScan 1572FS color monitor ■ programmable 124-key AnyKey™ keyboard

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If you like to travel light, you can't go wrong with the HandBook. It weighs only 2.75 pounds and measures roughly 6 x 9 inches — smaller than this magazine! Yet it has 286-class performance and real PC features including a bright, backlit screen, a bonafide 40MB hard drive and a comfortable keyboard (no chiclet keys). Downloading information from your HandBook to your office computer is easy with the serial cable and file transfer software provided.

HandBook ■ $1295

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33MHz 486DX ■ $2495

We recently increased performance and lowered the price of our best-selling, award-winning 486DX/33 by adding an ATI Graphics video card with a graphics coprocessor. At $2,495, the price/performance ratio on this machine is hard to beat. Plus, it's an upgradeable PC. You'll be able to switch to 66MHz later this year. ***System Highlights:*** 64K cache RAM ■ 4MB RAM ■ 200MB Western Digital IDE hard drive ■ ATI Graphics Ultra ■ 14" CrystalScan 1024NI VGA color monitor, up to 1024 x 768 non-interlaced resolution ■ desktop model is standard



50MHz 486DX2 ■ $2795

Gateway 2000's new 486DX2/50 systems, ISA and EISA, incorporate Intel's speed doubler technology. The internal core of the DX2 processor executes at 50MHz while communicating with the external memory bus at 25MHz. Our benchmarks show a 35% increase in performance over a 33MHz 486DX PC.

The high-performance ATI card is standard on the 486DX2/50 as well, plus this system incorporates our new RIDE technology for faster disk operations. RIDE stands for Rapid Integrated Drive Electronics. RIDE technology takes advantage of our new system BIOS that allows the drive to transfer bigger data blocks at one time. Our Coretest benchmarks show large block disk-to-memory operations are over 30% faster with RIDE. For example, you'll notice the increased performance whenever you type WIN at the system prompt, or when you double-click on an icon in Windows. It's much faster. Our product marketing director claims the 486DX2/50 with the ATI video card and RIDE is the fastest personal computer he's ever used!

System Highlights: 64K cache RAM ■ 8MB RAM ■ 200MB Western Digital IDE hard drive with RIDE BIOS ■ ATI Graphics Ultra ■ 14" CrystalScan 1024NI VGA color monitor, up to 1024 x 768 non-interlaced resolution ■ desktop model is standard



EISA SYSTEMS

Our product line includes two EISA systems — a 33MHz 486DX and a 50MHz 486DX2. Both EISA systems now come standard in a floor-standing tower model, and include large, fast SCSI drives and EISA SCSI controllers. RAM cache is expandable to 256K. The 486DX/33 EISA will be upgradeable to 66MHz later this year.

System Highlights: 128K cache RAM ■ 8MB RAM ■ 340 MB Maxtor® SCSI hard drive ■ 32-bit EISA SCSI controller ■ 16-bit Diamond Speedstar Plus SVGA graphics with 1 MB ■ 14" CrystalScan 1024NI VGA color monitor, up to 1024 x 768 non-interlaced resolution ■ floor-standing tower model is standard

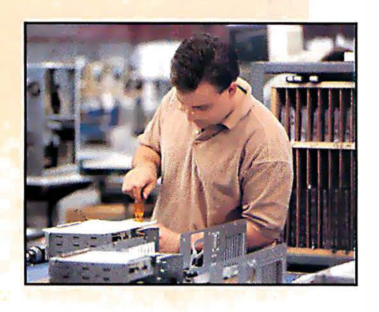
486DX/33 EISA ■ $3795 (Upgradeable to 66MHz later this year.)
486DX2/50 EISA ■ $3895

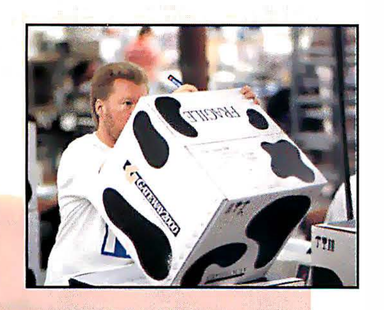
Gateway 2000 systems come fully configured with all the performance features you want, including two floppy drives, a programmable 124-key AnyKey keyboard, a Microsoft® mouse, MS DOS® 5.0, Windows™ 3.1 and your choice of one application software option. See the back pages of this ad for complete configurations and information about software options, upgrades and peripherals.



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There's a full team of dedicated service professionals standing behind your Gateway 2000 system. In fact, a recent *PC Magazine* reader survey proved Gateway the clear winner in service and reliability. We whizzed past all the contenders when PC owners were asked, "How likely would you be to buy the same brand system again?" The survey also rated Gateway Number-One in overall system reliability, and we were in the Top Five for tech support and repair service.

Whenever you call our sales number, you get a friendly, human voice — a helpful representative to provide you with information. In our customer support department, we have over 200 people on-line to supply free technical support for the life of your machine. They're experienced, rigorously trained and tested and ever patient, friendly and helpful. You'll see why we say "you've got a friend in the business" at Gateway 2000.

In our company mission statement, one of our stated objectives is to exceed customer expectations in quality, service and value. This objective is a personal challenge to each of us at Gateway. We know how important service is to you, which is why we're constantly striving to provide the best in the business.





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GATEWAY 2000 ADDS A BONUS PAYOFF

Choose Your Software Option

With the purchase of any Gateway 2000 computer system, you receive your choice of one application software option at no additional cost. We'll install your software on your hard drive, optimally configured for your system and Windows, and provide master diskettes and manuals. You may also purchase a second application software option, pre-installed, at extremely competitive prices.

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■ Best-selling word processor for Windows. New version 2.0 adds online help for *WordPerfect®* users

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■ Easy-to-use desktop presentations program creates high-quality overheads and 35mm slides

Option #4-*Borland® Paradox 3.5*

■ The award-winning database from Borland

Option #5-*The Entrepreneur Pack*

■ Includes the latest Windows versions of *Microsoft Works™*, integrating word processing, spreadsheet, and database in one easy-to-use program; *Microsoft Publisher™* for creating page layouts; *Microsoft Money™* to help you write checks, set budgets, track expenses; PLUS an *Entertainment Pack* with eight games, including *Tetris®*

Option #6-*The Windows Programmer Pack*

■ Includes everything you need to create programs for Windows: *Microsoft QuickC for Windows™*, *Windows Control Development Kit™*, *Windows Help Compiler™* and *Windows Programmers' Online Reference™*.

Option #7-*Microsoft Project for Windows™ 3.0*

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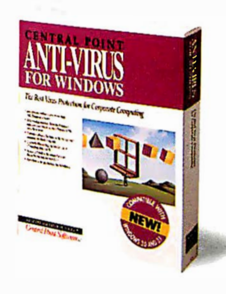
NOTE: If you would rather replace an above option with *Microsoft Office™*, it is available for $175. This package includes *Word for Windows*, *Excel* and *PowerPoint*.

New! Second Applications At Great Prices!

The following applications are only available with the purchase of a system, pre-installed, or to Gateway customers.

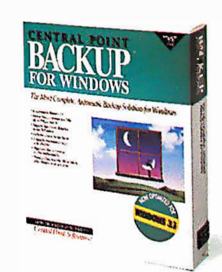
Central Point® Anti-Virus 1.2 For Windows

Central Point Anti-Virus provides the most comprehensive virus protection for both corporate and single-user environments. Easy to use and transparent, its automatic operation provides total virus protection and advanced protection against unknown stealth viruses. ■ $75



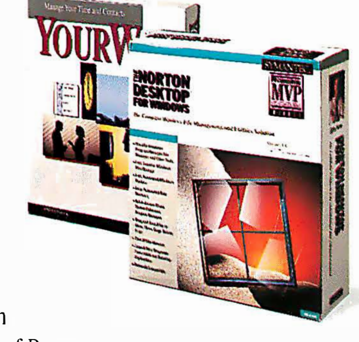


Central Point Backup™ 7.2 for Windows



This is the first reliable, easy-to-operate backup program to offer full-featured DOS and Windows applications in one package ■ $75

The Norton Desktop™ 2.0 and Prisma YourWay 2.0 For Windows



Norton Desktop is a complete file management and utilities program for Windows. It visually integrates file and group management with an extensive collection of Peter Norton's best utilities. YourWay is a personal time and contact management system for Windows from Prisma, including card file, task manager, report, calendar and call management functions. ■ $95

These offers include the identical applications contained in retail packages but will not include the retail box. You get all master diskettes and manuals, shrink-wrapped and packaged in a Gateway 2000 box.

Central Point Commute

Whether you're running Windows or DOS, Commute lets you take remote control of your personal computer with complete security. Transfer files quickly between PCs using Commute's advanced continuous data compression system and reduce transmission time up to 50%. ■ $49

Peripherals

The Gateway 2000 Telepath™ Fax/Modem

The Gateway 2000 TelePath is a 14,400 bps modem, V .32bis, with 9,600 bps fax capability. The TelePath comes with WinFax Pro,™ Crosstalk™ for Windows, Qmodem™ and a free 30-day basic services CompuServe® membership — all for only $195!

■ Fax mode: V.17, V.29 and V.27ter

■ Data mode: V.32bis, V.32, V.22bis, V.22, V.21, Bell 212A and 103, V.42 and MNP 2-4 error correction, V.42 bis/MNP 5 data compression

The 15-Inch CrystalScan 1572FS

The 15-inch CrystalScan color monitor has a flat, square, non-glare screen to reduce distortion around the corners and provide edge-to-edge display area. The CrystalScan 1572FS is an upgrade option only with the purchase of a 386DX or 486 system for an additional $195. (Availability is limited.)

Sorry — we sell peripherals only with the purchase of a Gateway 2000 system, or to people who are already Gateway 2000 customers. For fastest service, call our new direct line for the ***Component Add-On Division: 800-252-3333.*** *Please have your customer ID handy when you call.*





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- Simultaneous Video with 1MB
- Size 8.5" x 11" x 1.8", 5.8 Lbs.
- 6-Hr.* NiCad Battery & Charger
- 1 Parallel/1 Serial Port
- 79-Key Keyboard
- FieldMouse Pointing Device
- MS DOS 5.0 and Windows 3.1

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NOMAD 425DXL
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- Simultaneous Video with 1MB
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- 6-Hr.* NiCad Battery & Charger
- 1 Parallel/1 Serial Port
- 79-Key Keyboard
- FieldMouse Pointing Device
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- 16-Bit SVGA with 512K
- 14" CrystalScan 1024 Color VGA Monitor
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- 124-Key AnyKey™ Keyboard
- Microsoft® Mouse
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- Choice of Application Software

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- 1.2MB & 1.44MB Drives
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- 1 Parallel/2 Serial Ports
- 124-Key AnyKey Keyboard
- Microsoft Mouse
- MS DOS 5.0 and Windows 3.1
- Choice of Application Software

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- 64K Cache RAM
- 4MB RAM
- 1.2MB & 1.44MB Drives
- 200MB 15ms IDE Cache Drive
- ATI Graphics Ultra Video
- 14" CrystalScan 1024NI Color VGA Monitor
- 1 Parallel/2 Serial Ports
- 124-Key AnyKey Keyboard
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- 14" CrystalScan 1024NI Color VGA Monitor
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50MHz 486DX2 EISA
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- 124-Key AnyKey Keyboard
- Microsoft Mouse
- MS DOS 5.0 and Windows 3.1
- Choice of Application Software
- Tower Model is Standard

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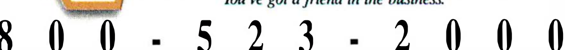
OTHER SYSTEMS
- Other systems in our product line: 16MHz 386SX, 20MHz 386SX, 25MHz 386DX, 33MHz 386DX, 33MHz 486DX EISA. Call for details and pricing.

** Battery life was measured using PC Magazine's Battery Rundown Test with power management enabled. Actual results may vary depending on configuration and applications.*

All prices and configurations are subject to change without notice. Prices do not include shipping. Components, peripherals and software are sold only with the purchase of a system, or to customers who already own Gateway 2000 systems. Some limitations apply.







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Born-Again Compaq?

ED PERRATORE

Compaq discovers the PC market's lower half with typical pride, atypical price

Down but hardly out, Compaq has fired its own salvo at the many smaller companies that have chipped from beneath at its market share. The company is betting the farm on a daring offensive comprising three new notebooks, enhancements to the existing Deskpro/M line, a new Deskpro/I line for midrange needs, and—the greatest departure of all—a new ProLinea line with list prices beginning under the magic $1000 mark.

Compaq has renegotiated many agreements with component vendors—resulting in many parts being dual-sourced—to induce competition that prevents any single component from increasing unit pricing. The company has also streamlined its manufacturing and assembly procedures to address the bottom line: Compaq intends to produce the new models at the fastest possible pace while still maintaining quality. The on-site factory hopes to meet anticipated demand by producing one ProLinea system per minute.

The I's Have It

Compaq's answer to calls for further reductions in Deskpro/M pricing is the Deskpro/I line. The five ISA-bus slim-line models range from 25-MHz 386DX to 66-MHz 486DX2 configurations, offer three horizontal slots, and integrate the QVision 1024- by 768-pixel graphics accelerator with 512 KB of VRAM (video RAM), which is expandable to 1 MB if you want 256 colors at high resolution. An Intel 387 socket and a fast 16-KB four-way set-associative cache will ship with the 25- and 33-MHz 386 models. An optional 64-KB cache can accompany the 25-, 33-, and 66-MHz 486 products for increased performance over the 8 KB you get with the processor.

The Windows-bundled Deskpro/I models demonstrate the international splash Compaq wants to make: Windows comes preinstalled for five languages. An automatic routine will initially have you select one, delete the other files, and reconfigure Windows.

Because the Deskpro/I models can accept any Intel processor's pin-outs, you can freely upgrade them. A single switch bank shuts off the 386 processor and cache controller so you can swap out the old CPU. Compaq's dream is that you'll install this old CPU—say, a 33-MHz 386—into a Deskpro/I 25-MHz 386 model to keep things in the family.

Don't Call It Multimedia

One exciting innovation is an integrated feature called *business audio*, the result of a joint venture among Compaq, Analog Devices, and Microsoft. Called thus to distance it from the oft-criticized and typically less specific *multimedia*, business audio will let you embed speech and other sounds—represented by an icon—into, say, an Excel spreadsheet. This audio clip could be a spoken request that the next user check certain figures. If the spreadsheet details a successful year's profits, it might be the fourth-movement theme of Beethoven's Fifth Symphony. Other possible uses include dictation for transmission across a network, training on a variety of levels, and presentations enhanced with voice or music. Call it a poor man's Next computer...but the Deskpro may be listening.

In the Deskpro/I PCs and the newer Deskpro/M PCs, Analog Devices' dual-



The Compaq ProLinea 3/25s is one of two 25-MHz 386SX models intended for users with limited budgets and experience.

channel AD1848 chip will handle stereo record and playback tasks (with up to 48-kHz sample rates) using a pair of ADCs (A/D converters). This chip, providing a byte-wide parallel interface to either EISA- or ISA-bus systems, supports one or two DMA channels. Jacks on the PC include microphone-in, headphone-out, line-in (from CD or tape players), and line-out (to external speakers or recording devices).

Accompanying software includes utilities for functions like mixing and controlling playback volume. Microsoft will provide a Windows 3.1 interface and application-specific add-ins. In fact, two Windows tools already support business audio: Sound Recorder enables sound recording and playback; the control panel's sound option lets you attach sounds to system events (e.g., the closing of a file).

As an aside, this business venture is not the only one involving big-name companies. In early May, Lotus Development announced its own product for embedding audio in PC files. Lotus Sound will be bundled with third-party hardware for annotating a file (created in any Windows OLE-enabled application) with sound, presented in a similar fashion to Compaq's business audio.

If you won't settle for less than full Compaq functionality and have the budget to prove it, you'll find the Deskpro/M line more enticing than ever. These models come with the QVision accelerator, which includes a hardware cursor for speeding Windows applications and a true-color RAMDAC. For business audio needs, the M machines come with a small microphone for speaking into the Windows files you create (also shipped with the Deskpro/I models), an external audio adapter, and software.

Sub-Compaq Pricing

For the Deskpro/I line, expect to see list prices from under $2000 for models without hard drives to about $3000 for models with a 120-MB hard drive. These prices are similar to those for the Dell 486/P and the AST Premium II after discounting for Compaq street pricing. (All Compaq prices are for systems without monitors.) Add $500 to $700 for a similarly configured Deskpro/M.

If you're willing to forgo some of the Deskpro/I's features and expandability for even lower prices, for once Compaq can accommodate you there, too. The new ProLinea line, targeted toward mainstream users who don't need high levels of performance, is made up of two entry-level 25-MHz 386SX models and one plain-vanilla 33-MHz 486. List pricing for the lowest-level 40-MB hard drive–equipped system will be about $1000, and the 486 with a 120-MB hard drive should run about $2000. (The same $500 to $700 price difference lies between a ProLinea and a similarly configured Deskpro/I.)

What you get for these attractive prices is less than you've ever seen in a Compaq system. The lower-end 25-MHz 386SX small-footprint system, the ProLinea 3/25zs, includes 2 MB of RAM (expandable to 16 MB), a 387SX socket, a 1.44-MB floppy drive (a concealed 3½-inch slot takes a hard drive), a VGA adapter with 512 KB of nonexpandable VRAM, two ISA slots, and a lowly 70-watt power supply that Compaq insists is sufficient for whatever you can squeeze into the system. This machine has no caching whatsoever. The small single-sided motherboard of the 3/25zs, coupled with the limited slots and drive bays, makes for a wee 3½- by 12½- by 15-inch case.

Spend a few hundred dollars more, and you get the slightly larger ProLinea 3/25s. With this machine, you have a choice of a 120- or 84-MB hard drive (or none at all); an extra 5¼-inch drive bay for another floppy drive, tape backup drive, or CD-ROM drive; another 16-bit slot; and a 145-W power supply to handle the extra load. And if you're very, very sure you want a few-frills 486 system, the ProLinea 4/33 adds an additional 2 MB of RAM and a full 1 MB of VRAM.

DOS is preinstalled on ProLinea hard drive–equipped models, and systems bundled with Windows, a mouse, and Spinnaker Software's PFS:WindowWorks are available as well. The bundling of a low-end integrated package such as PFS:WindowWorks underscores Compaq's clear message: If you want power, these market-driven systems are not for you.

Compaq also announced three new notebooks. One, an addition to Compaq's existing LTE Lite line, uses an active-matrix color screen matching the display quality of the high-end Compaq Portable 486c. The other two are 20- and 25-MHz 386SL systems sporting a different form factor from the LTE Lite models and, presumably, competitive pricing.

I had the opportunity to run BYTE's DOS benchmark tests on prototypes of two of the new models: the ProLinea 3/25s (a three-slot 25-MHz 386SX) and the 33-MHz 486 Deskpro 4/33i. The ProLinea scored in the range of the older Compaq Deskpro 386/25e, even besting this system on a few of our CPU tests. The Deskpro 4/33i ranked slightly behind the Tandon 486/25 in CPU tests, compensating with speedy disk and video scores.

A New Compaq?

Several things are notable about Compaq's new products. First, contrary to rumors, none of the new machines are OEMed from other vendors. Second, the company claims to use the same high-quality components for which Compaq is known; the two lower-end lines merely offer fewer features. And third, the company hopes to dispel its image of being insensitive to users with new benefits like toll-free support and one year of free on-site service. Compaq notes that the technician who picks up the phone will remain the caller's primary contact even if the problem involves integrating another vendor's product into a Compaq system.

In addition to a new CompuServe-administered support forum, Compaq is developing its so-called SmartSystem, a technical-support expert system that is based on Sybase's SQL Server.

From the apparent results of the company's recent soul-searching endeavor, it looks like Compaq is back in the running. Its greatest challenge now is selling the budget-conscious public on the new Compaq image—one of continued quality in the face of frugal reality. ■

Ed Perratore is a news editor for BYTE. He can be contacted on BIX as "eperratore."

THE FACTS

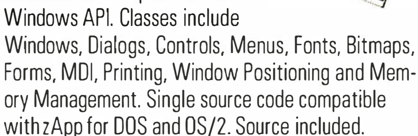
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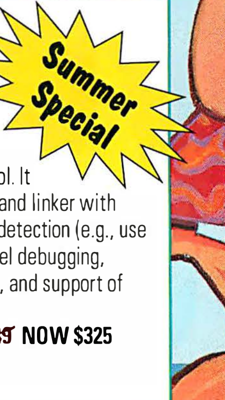
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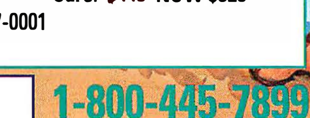
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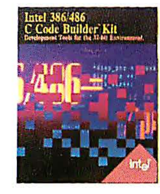
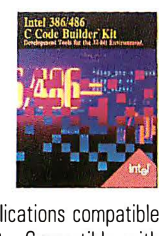
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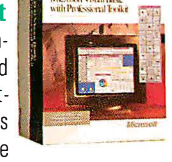
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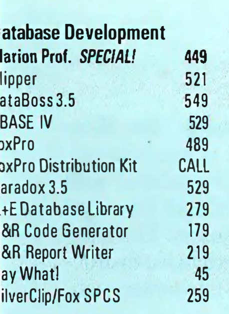
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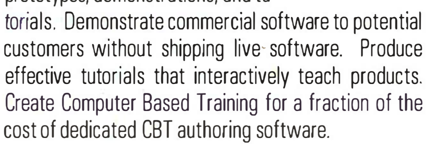
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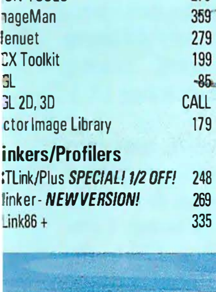
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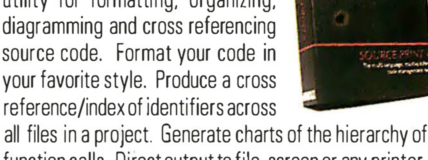


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Radius Brings Photo-Realism to Windows

Couple the Radius **MultiView 24** graphics board with a monitor that will handle the high bandwidth of its output (e.g., the Radius PrecisionColor Display/20), and you have a PC setup that will easily handle the impressive realm of photo-realism. Once you've seen a 1024- by 768-pixel, 24-bit (16.8 million colors) image, you won't want to go back. There's a substantial price to pay. Such a setup will lighten your wallet by about $5000—$1999 for the board alone.

Until recently, photo-realism was the sole realm of Mac aficionados, but the arrival of high-performance software and hardware has finally brought it to the PC platform. And what better company to push the technology to its limit than Radius, which made its well-deserved reputation in graphics hardware for the Mac.

Of course, 24-bit graphics boards are not new, but the prerelease version of the MultiView 24 that I worked with is one of the fastest on the market. Yet its $1999 price tag is on the low side when compared to its competitors'.

Performance is everything in the world of 24-bit graphics. Pushing around all the pixels required for a 1024- by 768-pixel, 24-bit full-color image requires a great deal of processing power. It's not a job for your computer's internal processor, unless you're looking for molasses-slow performance. The MultiView 24 takes all the graphics-processing work away from your 386- or 486-based system with a variety of technology. Three Western Digital 8514/A chip sets are at the heart of the board, each handling 8 bits of color. Getting them to work together at high speed wasn't a trivial undertaking. Radius uses proprietary technology and 3 MB of VRAM (video RAM). There's a programmable frequency synthesizer for the pixel clock, which you can customize to your monitor.

A board like this needs and deserves a high-end monitor. The PrecisionColor Display/20 that I used with the MultiView 24 had a maximum horizontal scan rate of 60 kHz. That let me use the board's top output, displaying 1024 by 768 pixels noninterlaced with a refresh rate of 72 Hz. This gave a rock-steady, absolutely flicker-free image that doesn't tire your eyes. With a less capable monitor, you can still display 1024 by 768 pixels, but with lower refresh rates.

Installing the MultiView 24 was easy. This isn't a small board, though. It's a full-length and full-height AT configuration, which won't fit in many of today's compact computer cases. You use the board in conjunction with your system's existing VGA board, connecting the MultiView 24 to the VGA board with an internal jumper cable.

The setup software is some of the best I've seen, making the process automatic while leaving room for customization if you're using a monitor that's not on the installation software's menu. The Windows driver installation is a revelation, and it doesn't require you to deal with those pesky OEMSETUP.INF files that are the bane of Windows users. The manual is excellent; it gives extensive instructions and guidance if you encounter problems.

A graphics board like the MultiView 24 isn't the logical choice if you're doing mundane chores like word processing—unless you have a bottomless bank account. But if you work with color graphics, it's ideal. My preliminary benchmarks show that the MultiView 24 is as fast as (and sometimes faster than) a garden-variety 8-bit VGA board. I found that surprising and indicative of the shape of PC graphics to come.

—*Stan Miastkowski*

THE FACTS

MultiView 24
$1999

Radius, Inc.
1710 Fortune Dr.
San Jose, CA 95131
(800) 227-2795
(408) 434-1010
fax: (408) 434-0770
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LanRover/L Unites PowerBooks and AppleTalk Networks

The PowerBooks, Apple's notebook computers, provide on-the-go Macintosh computing. Bundled with every PowerBook is a nifty product called ARA (Apple Remote Access). ARA is an application/Control Panel/Extension trio that lets a PowerBook dial into another Mac running ARA and appear as a node on the host Mac's AppleTalk network. With ARA, you can access networked resources like servers and printers as you would on your office Mac, even though you might have called across the country with your PowerBook.

As you might expect, ARA has a catch: A Mac with a modem in the office must host the ARA software—not the most effective use of a computer. Shiva offers a cost-effective solution to dedicating a system for ARA use. The **LanRover/L** is a $699 unit that plugs into your AppleTalk network and uses a 10-MHz 68000 processor and custom firmware to act as an ARA server. It provides a reliable dial-in access point to your office network without tying up a Mac. When it's not in use by PowerBook-toting field personnel, office workers can dial out of the idle LanRover/L as a networked modem.

The LanRover/L is a small gunmetal box with two mini-DIN-8 connectors. One connector plugs the LanRover/L into a LocalTalk network; the other one connects it to the modem. A Shiva Net Manager application lets you configure the LanRover/L's users, their passwords, and dial-back phone numbers, just as if you were setting up the access rights with ARA.

In fact, one of the program's main strengths is its similarity to ARA's configuration and usage styles. Furthermore, the software uses ARA's own modem CCL (connection control language) files. This has two advantages. First, when a vendor issues an ARA CCL file with a new modem, this automatically makes the modem available to the LanRover/L. Second, overseas users using vastly different modems can use the LanRover/L, as long as the modems have a corresponding CCL file.

I jacked a beta LanRover/L unit into BYTE's LocalTalk network section and used a Hayes Ultra 96 modem to provide the outside connection. From home, I was able to connect a PowerBook 170 to the office network using a Global Village PowerPort 9600-bps modem. To use a network effectively via ARA, you need the fastest modem possible, and the Power-

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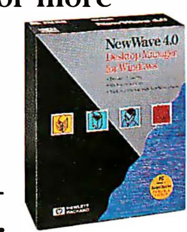
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Port does a fine job. I was able to move through the various AppleTalk zones and access the AppleShare and NetWare servers that reside on the network's Ethernet section. The password protection and callback features worked reliably.

When you are back in the office, you can examine a log file that is stored in a 10-KB buffer within the LanRover/L that holds about 400 entries. The log shows what users called, when, and for how long. Password violations, on either dialing in or dialing out, are clearly flagged in red text on a color Mac.

Shiva's LanRover/L provides a reasonably priced solution (assuming you already own a high-speed modem) that allows remote network access without compromising the security of your network or dedicating a Mac. When the time comes, you can substitute a higher-speed modem without disrupting your user settings. The LanRover/L provides the means for offices with many mobile workers to keep in touch.

—Tom Thompson

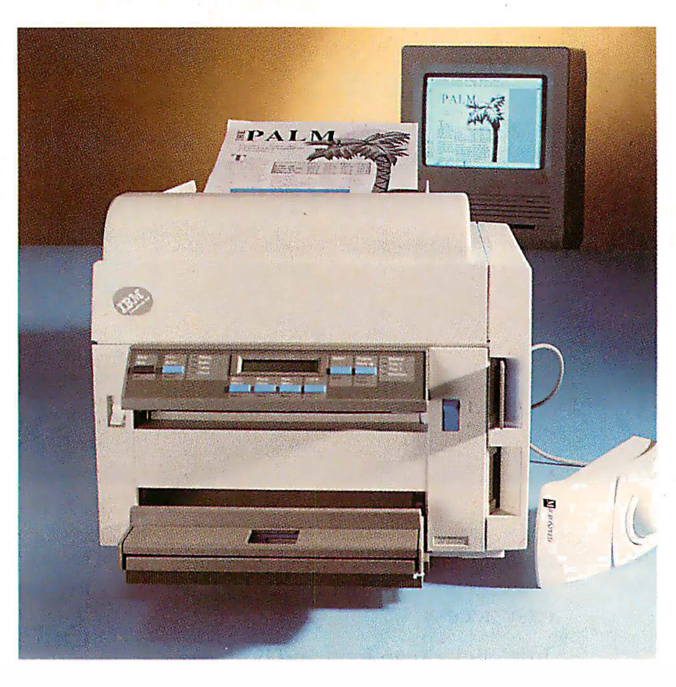
THE FACTS

LanRover/L
$699

Shiva Corp.
1 Cambridge Center
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(617) 252-6300
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Lexmark's Apple Printer Alternatives

Looking at a printer with an IBM logo connected to a Mac just doesn't seem right. But that's what the world has come to, and the new line of customized-for-Mac printers from IBM/Lexmark is a fine marriage of disparate manufacturers.



The **IBM LaserPrinter 10A** that I connected to my Mac SE/30 was fresh off Lexmark's robotized assembly line in Lexington, Kentucky. (Lexmark is an independent company that purchased IBM's printer operation in 1991, retaining the right to use the IBM logo on its products.)

The 10A is the top-of-the-line printer of four for the Mac. The other three are the 10P, 6A, and 6P. The 10A and 10P are 10-page-per-minute units based on a 68020 processor running at 16.7 MHz with 5 MB of RAM. The 10P lacks the LocalTalk interface of the 10A. The 6A and 6P are 6-ppm units with a 10-MHz 68000 processor and 2 MB of RAM. The 6A has a LocalTalk interface while the 6P does not. All four printers are PostScript-compatible.

I wasn't surprised at the quality of the 10A because I'd used it before. Actually, all four of these printers are about a year old. Lexmark has taken its flagship PC printers and packaged them to run on the Mac platform. All the parts and pieces required (e.g., the PostScript option, extra memory, and the LocalTalk interface) have been available separately. Lexmark has put them all together and lowered the price. The company has even rewritten its manuals to match the Apple style. Throw in software for the Mac, and you have a series of printers that you can have up and running minutes after you open the box.

Pulling the printer out of the box is a one-person job (the toner cartridge is already installed), and the software installation is a snap. All four printers come with software for both System 6.0 and System 7.0. The IBM LaserPrinter DA (desk accessory) lets you select the features of the printers. All four printers include PQET (Print Quality Enhancement Technology). This smoothes edges on graphics and text, resulting in impressive quality.

But there's more. The 10A and 10P include true 600- by 600-dot-per-inch print resolution. For applications like desktop publishing or other graphics work, the quality is close to typeset, and it's perfect for masters of documents that will be offset-printed in bulk.

I'm impressed by the quality of the 10A. It's deceptively light but built like a tank. The PC version has proved itself in numerous heavy-use applications here at BYTE. Since the Mac versions are the same printers at heart, I'd expect the same from them.

With this many features, you'd expect these printers to be expensive. Not so. In fact, their list prices average 15 percent to 20 percent below comparably equipped printers from Apple and other manufacturers. And the street prices of the LaserPrinter series are often considerably below list. The low prices and numerous features of these printers for the Mac make for an unbeatable deal, indeed.

—Stan Miastkowski

THE FACTS

IBM LaserPrinter 10A
$3995; 10P, $3795; 6A, $2695; 6P, $2295

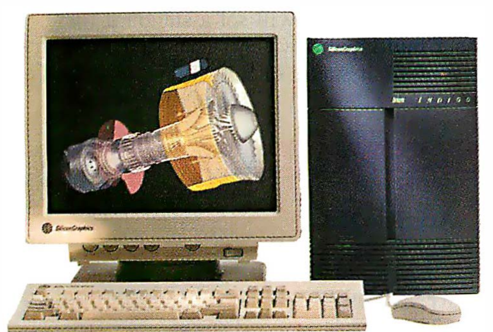
Lexmark International, Inc.
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Lexington, KY 40511
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fax: (606) 232-2380
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Acer Delivers the Infotainment Appliance

Are you contemplating a shopping spree to pick up a new computer, a CD player, an AM/FM tuner, a fax board, a telephone, and an answering machine? If so, you can now get all these components and more bundled together in a single multimedia computer from Acer America.



I looked at a market-ready version of the remarkable **AcerPac 150**, which may be the first true "infotainment" appliance. Not so much a technical breakthrough as a triumph of integration, the AcerPac 150 could become the hub of your home or business information and entertainment complex—for much less than the cost of the pieces bought separately. And it's so easy to use that you can be up and running in minutes.

The heart of the system is a slim-line 20-MHz 386SX computer with DOS, Windows, a CD-ROM drive, and add-in hardware that handles digital audio, fax, and telephone functions. A colorful point-and-click interface gives quick access to all these functions. The system doesn't carry an MPC logo, but it is fully compliant with MPC standards and will play all compatible software.

Out of the box, the sleekly designed Acer-Pac 150 includes 4 MB of RAM, a fast 130-MB hard drive (a wise decision, considering how space-hungry multimedia applications are), a 3½-inch floppy drive, a 101-key keyboard and mouse, standard I/O ports, a VGA monitor, and one free ISA-bus slot. The built-in CD-ROM drive has a decent 350-millisecond average access speed.

The multimedia hardware is built onto a daughterboard and a bus card. It includes a fax modem (2400-bps data and 9600-bps send/4800-bps receive fax), a telephone, an audio card (compatible with Sound Blaster and Ad Lib), an AM/FM stereo tuner and mono speaker, a MIDI/game port, and jacks for external speakers, headphones, a microphone, and stereo input.

Bringing all these functions to life is a wealth of bundled software: DOS 5.0 and Windows 3.0 with multimedia extensions, Microsoft Works (the multimedia version), and Delrina's WinFax Pro 2.0. To sweeten the deal, Acer includes copies of Microsoft Bookshelf, QBasic, and Windows Entertainment Pack; Compton's Multimedia Encyclopedia; and a 30-day subscription to Prodigy.

Setting up this system is a lot easier than connecting all the components it replaces. In fact, the hardest job was wiring up the external stereo speakers. In my first half hour using the AcerPac 150, I blasted my favorite radio station, called my friends using the built-in speakerphone, and sent a fax to my home. Then, from another office, I sent the system two faxes and left myself some phone messages—all while running a Windows paint program.

Of course, you probably don't want to leave your computer powered on all the time just to receive faxes and phone calls. With the AcerPac 150, you don't have to: The system includes an ingenious telephone-activated suspend/resume function called StartSmart. When a call comes in, the computer wakes itself up and answers within four rings, separating faxes from voice calls, routing them to the appropriate software program, and shutting itself down again. A front-panel LED even blinks to indicate you have a message or fax, just like on a regular answering machine.

The AcerPac 150 is the system the multimedia Tandy 2500SX/20 should have been. Acer's achievement is in the details: The integration between the media subsystems is seamless, the performance is balanced, and the user interface is nearly perfect. (I'm especially fond of the Music Center, a rendition of stacked audio components, complete with LEDs, push buttons, and sliders.) Every decision about the design was thoughtful. For example, the system enclosure is screwless, and there are even front-panel volume controls.

This computer represents a new step in the evolution of multimedia. Although it is grounded in traditional technologies—an Intel CPU, Windows software, and desktop packaging—the AcerPac 150 is dramatically different because it replaces many standalone devices. The one major piece missing from the puzzle is digital video, which is still too new and expensive to be integrated into such a practical system. Just wait a few more years.

A more home-oriented version of the AcerPac 150 is also available. The Acros 380 is functionally the same as the AcerPac. Its differences lie only in appearance. The Acros 380 is being marketed through such outlets as Circuit Cellar, Circuit City, and Staples. Acer expects that the AcerPac 150's street price will be in the same range as the Acros 380's price.

My only criticism is that the I/O ports on the back aren't labeled with icons, which could confound novices. This is a minor quibble, to be sure, but it tells you how hard I had to look to find something wrong. The AcerPac 150 will set a standard for other multimedia systems to match. And best of all, it's a lot of fun. ■

—Andy Reinhardt

THE FACTS

AcerPac 150
$2995

Acros 380
$2399

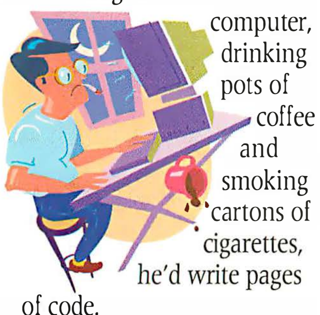
Acer America Corp.
2641 Orchard Pkwy.
San Jose, CA 95134
(800) 733-2237
fax: (408) 433-5283
Circle 1216 on Inquiry Card.



Why do they call it a dongle?

He wasn't famous. He didn't drive a fancy car, but dressed in his favorite Comdex T-shirt and faded blue jeans, he set out to change the course of the computer software industry. Quite a task for a lonely software developer.

Sitting in front of his computer, drinking pots of coffee and smoking cartons of cigarettes, he'd write pages of code.



It took time. Years in fact. But he did it. He wrote the most powerful computer program in the world. Now came the hard part. Selling it.

The Most Powerful Program in the World

Determined to make those long years pay off, he called on every distributor, VAR and dealer in the world. He drove from Beantown to San Diego. Flew from Dublin to Borneo. Everyone loved the program.

So he sold a few. Only a few.

Back in Boston he waited. After a long year with only 13 orders he set out to see what happened. As he drove across the country and flew around the world he discovered everyone knew about his program. Everyone had it too.

The Global Marketplace

From Paris to Prague, his program was everywhere in Europe. When he got off the plane in Hong Kong he found his program stacked to the ceiling in every computer store. Amazed in disbelief, he bought a hundred cartons of cigarettes and a hundred pounds of Indonesian coffee and flew back to Boston.

Beaten, battered and bruised he went back to the drawing board. This time he would really change the face of the software industry. He would develop a device that would prevent unauthorized distribution of software programs.

Call It What You Like

He developed a hardware key. His peers applauded his efforts. Finally, a solid solution for revenue protection.

But he didn't know what to call it. He thought of naming it after an exotic place he visited in his travels. Madagascar was a bit too long, though.

"Name it after you, Don!", urged his peers. So he did. Soon everyone was calling the key a dongle, after Don Gall — the lonely software developer who did what he had to do.

You've Come A Long Way, Baby

Today, dongles are different. Fact is, they've come a long way. Leading the industry with security solutions, Rainbow Technologies has changed the face of hardware keys. They work with multiple applications, are programmable and network versions control concurrent usage. And they're always transparent to the end-user.

Sentinel Family from Rainbow

Truth is, more and more developers are using keys. And the Sentinel Family is the most widely used in the world. In fact, over 6,000 developers use Sentinel from Rainbow. Why? They are simply the most effective, reliable and easy to implement keys on the market.

Learn more about securing your software and how keys provide developers with extra value. Call for a free copy of **"The Sentinel Guide to Securing Software."** And see just how easy it is to install a hardware key into your application in just minutes. Try it with our low cost Sentinel Evaluation Kit. Order one for your DOS, OS/2, Windows, Macintosh or UNIX based application.

And remember, when you need a dongle, you need Sentinel — the only dongle Don Gall would use.

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Some call it a dongle. Those who know, call it Sentinel.



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(actual size)

AMD Introduces The World's First 386 Microprocessor With 3-Volt Technology.

Two standard dry-cell batteries. There's really nothing special about them. Aside from the fact that they can run a powerful, portable 386 computer for a full eight hours. Provided, of course, that portable is built around a low-voltage Am386™ microprocessor.

The 25MHz DXLV and the 25MHz SXLV are available in PQFP packaging.

Thanks to the low-voltage Am386 microprocessors, laptop, palmtop and notebook computer designs will become smaller, lighter, and more powerful than ever before.

With battery life of up to eight hours or more. That's a full day's worth of 386 performance—the per-

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formance you need to run sophisticated applications like Windows™ 3.0.

And rest assured, the low-voltage Am386 microprocessors are proven compatible and comply fully with JEDEC standards for low-power, 3-volt computing. We can even supply you with the 3-volt EPROMs your systems will need. Other 3-volt system logic is also readily available.

For more information on the low-voltage Am386 microprocessors call AMD today at **1-800-222-9323**. You'll never look at dry-cell batteries the same way again.



Clock-Doubled Performance

The CompuAdd 450DX2 computer gets its performance from the DX2-50 microprocessor, which runs at 50 MHz. The unit's system board has a hot slot for use with CompuAdd's Hi-Rez VGA video controller, which enhances video performance by operating at an effective rate of 12.5 MHz. The board also has a socket for a math coprocessor.

Basic configuration of the machine is 4 MB of RAM (expandable to 64 MB), an 80-MB hard drive, dual floppy drives, and a monochrome monitor. You can replace the hard drive with a 120-, 200-, or 425-MB IDE drive or a 330- or 630-MB SCSI drive. The system BIOS is stored in a flash EPROM, letting you update it by uploading the new code from a floppy disk. The unit has a parallel and two serial ports.

Price: $2195 and up.

Contact: CompuAdd Computer Corp., 12303 Technology Blvd., Austin, TX 78727, (800) 456-3116 or (800) 627-1967.

Circle 1271 on Inquiry Card.



The CompuAdd 450DX2 is powered by the DX2-50 chip.

Feature-Rich SL-Based Notebooks

The N3/SL25 Color and the N3/SL25 Plus notebooks include a SCSI-2 connection that lets you hook up as many as seven SCSI peripherals. An enhanced parallel port lets you connect to a network.

The N3/SL25 Color has a 32-KB memory cache and 2 MB of RAM (expandable to 10 MB). The 6.9-pound unit includes a J mouse, a serial port, ports for a PS/2-style external keyboard/mouse and an external monitor, and a 60- or 80-MB hard drive. The notebook has a 1.44-MB floppy drive, suspend/resume mode, user-selectable power management, a 9-inch passive-matrix 256-color display, and an optional 9600-bps send/receive fax modem.

The 7-pound N3/SL25 Plus—slightly smaller than a legal pad—features a separate numeric keypad, an integrated trackball, and a built-in 2400-bps MNP level 10 modem with fax-sending capability. It has a 10-inch monochrome triple-super-twist sidelit LCD with 64 shades of gray.

Price: N3/SL25 Color with a 60-MB hard drive, $3799; N3/SL25 Plus with an 80-MB hard drive, $2999.

Contact: Leading Edge Products, Inc., 117 Flanders Rd., Westborough, MA 01581, (508) 836-4800; fax (508) 836-4504.

Circle 1272 on Inquiry Card.


N3/SL25 Plus

Multimedia at Your Desk

ALR's 25-MHz ISA-based PowerFlex Flyer 3SX/25 MPC desktop system has 4 MB of RAM (expandable to 16 MB) on the system board, which also has an IDE interface, and an 80-MB IDE hard drive. The 16-bit unit includes an internal Sony CDU-31 ACD Unit and a Pro Audio Multimedia Board.

Other features include a Phoenix flash BIOS, a Flex-View 3X 14-inch Super VGA color monitor with 1024- by 768-pixel resolution, five expansion slots, a 1.44-MB floppy drive, and one parallel and two serial ports. Software includes DOS 5.0, Windows 3.1, and Works.

Price: $2795.

Contact: Advanced Logic Research, Inc., 9401 Jeronimo, Irvine, CA 92718, (714) 581-6770; fax (714) 581-9240.

Circle 1273 on Inquiry Card.

Scalable 486s

The modular DECpc 400ST series of 486-based PCs and scalable workstations uses Intel's scalable Xpress architecture for easy upgrading. Designed as department servers or multiuser systems, the DECpc machines run Pathworks, NetWare, Vines, and SCO Unix, as well as DOS 5.0, Windows 3.1, and OS/2 1.3 and higher.

Standard features of the series include 8 KB of internal cache, 4 MB of RAM (expandable to 192 MB), a 1.44-MB floppy drive, six EISA bus-master expansion slots, three front-accessible storage bays, a hidden bay, two serial ports, and a parallel port. Maximum disk capacity is 3.4 GB.

The DECpc 425ST has a 486SX processor and operates at 25 MHz; it is upgradable to 33 or 50 MHz and has 64 or 128 KB of external cache. The 486 DECpc 433ST operates at 33 MHz and is upgradable to 50 MHz; it also has 64 or 128 KB of external cache. The DECpc 450ST has a 486 processor and operates at 50 MHz; standard external cache is 250 KB.

Price: $4397 to $6595.

Contact: Digital Equipment Corp., 146 Main St., Maynard, MA 01754, (508) 493-5111; fax (508) 493-8780.

Circle 1274 on Inquiry Card.

Back Up on Tape via IDE Interface

The Summit Express SE305, a 305-MB minicartridge tape backup subsystem, uses an IDE embedded AT interface. The 5¼- or 3½-inch half-height drive has file backup and restore rates as high as 10 MB per minute without the use of an external controller card or slot.

Configured with SummitSafe software for DOS, NetWare, and NetBIOS LAN applications, the Summit Express SE305 gives you the option of having the subsystem configured with SCO Unix software. Software data compression enables the drive to hold up to 305 MB of data when reading and writing in Summit's SMS-101 format. The drive reads and writes in QIC-80 format for 250 MB of storage.

Other features include a backup/restore data throughput rate of up to 10 MB per minute with the SMS-101 format, 64 KB of on-board RAM, and disk ROM BIOS compatibility. Support is available for multitasking operating systems via the optional IDE paddle card adapter.

Price: $695.

Contact: Summit Memory Systems, Inc., 100 Technology Cir., Scotts Valley, CA 95066, (408) 438-2660; fax (408) 439-6725.

Circle 1275 on Inquiry Card.



The Summit Express SE305 tape backup uses an IDE interface.

External Drive Travels with You

A portable external hard drive, Data Traveler connects to your laptop or PC via the parallel port to provide convenient extra storage capacity for your system. Available in capacities of 52, 84, 105, and 240 MB, the under-3-pound unit features a Quantum IDE hard drive, has input and output parallel ports, and tucks into your briefcase.

Price: $795 to $1995.

Contact: Kingston Technology Corp., 17600 Newhope St., Fountain Valley, CA 92708, (714) 435-2600; fax (714) 435-2699.

Circle 1276 on Inquiry Card.

Sun Speed on a Rewritable Optical Disk

More than a storage disk, the Opti/Max SCSI rewritable optical disk subsystem is an effective boot disk for Sun workstations. With an average access time of 7.6 ms, a read/write data transfer rate of 1 MBps, and use of the standard Sun driver, the Opti/Max shows the highest performance available in rewritable optical disk subsystems, according to Unison.

Intended for use with Unix workstations using the SCSI bus, the subsystem consists of a 5¼-inch rewritable optical disk, a Unison-proprietary SCSI-to-SCSI caching controller, and a 220-W uninterruptible power supply. DMA transfers the data from the built-in memory cache to the optical disk, letting the caching controller simultaneously flush the cache and process requests from the host computer. Cache size ranges from 4 to 32 MB; each rewritable optical cartridge has a 600-MB capacity.

Price: $5000 to $10,000.

Contact: Unison Information Systems, Ltd., 21 Walsh Way, Framingham, MA 01701, (508) 879-3200; fax (508) 879-0772.

Circle 1277 on Inquiry Card.

Mac Magneto-Optical Disks

The Condor 650e and 130e rewritable magneto-optical disk subsystems for the Mac are removable, split-head optical units. The subsystems support applications such as desktop publishing, CAD/CAM, multimedia, and medical imaging.

The 5¼-inch Condor 650e runs at 3600 rpm and has an average access time of 37 ms. Its maximum data transfer rate is 2 MBps, with a sustained rate of 1 MBps. The 3½-inch Condor 130e's average access time is 43 ms, and it has a maximum data transfer rate of 1.5 MBps, with an average of 640 KBps. Both subsystems include motorized cartridge load and unload and direct seek. The 650e features a completely dustproof design.

Price: Condor 650e, $4679, $269 per cartridge; Condor 130e, $2498, $99 per cartridge.

Contact: Rodime Systems, Inc., 7700 West Camino Real, Boca Raton, FL 33433, (407) 391-7333; fax (407) 391-9950.

Circle 1278 on Inquiry Card.

Speed Scanning for Unix and Sun

Designed for document image management applications on Unix and Sun Microsystems platforms, the M3096G high-performance SCSI scanner handles paper as large as 11½ by 17 inches. Able to scan at a rate of 2.2 seconds per page, or 20 ppm, the M3096G can process up to 50 documents at a time using its automatic document feeder.

The scanner recognizes 256 gray scales and has a maximum scan resolution of 400 pixels per inch, letting you scan photographs. The optional Sun Kit lets you integrate the scanner with Sun workstations. Components of the kit include the M3096G Sun Sparcstation driver and a compression board with 4 MB of RAM for standard Group 3 and Group 4 fax compression.

Price: $6720; Sun Kit, $2200.

Contact: Fujitsu Computer Products of America, Inc., 2904 Orchard Pkwy., San Jose, CA 95134, (800) 626-4686.

Circle 1279 on Inquiry Card.

Click Between DOS and Unix

The Opus Systems SPARCard 2 coprocessor board for PCs features specialized system software that integrates DOS and Unix environments. With the board installed, you can switch back and forth between DOS and Unix with a single keystroke or mouse-click and transfer files between the environments.

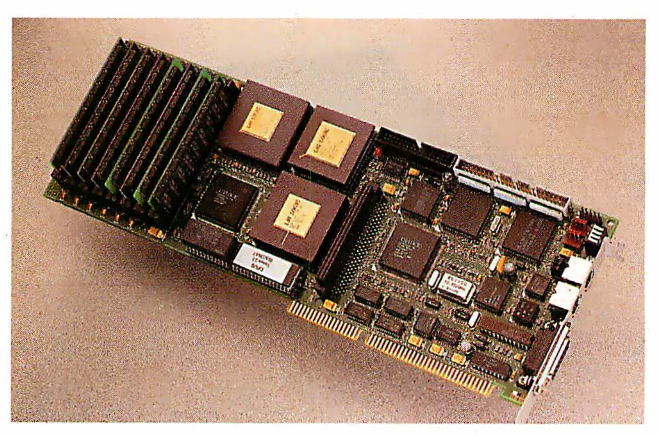
Based on the 40-MHz SPARC processor, the card is 100 percent binary compatible with all SPARC hardware and software from Sun Microsystems and Sunsoft. You can simultaneously run DOS/Windows and 3500-plus SPARC applications from the same keyboard or mouse and view them on a single monitor.

The SPARCard 2, rated at 28.5 MIPS, provides the full functionality of a Sun Sparcstation 2 motherboard. The card includes a dedicated FPU and memory.

Price: $4145; SPARCard 2 Kit with a card, 8 MB of RAM, a 213-MB hard drive preinstalled with Solaris 1.0, and a color frame buffer, $6265.

Contact: Opus Systems, 329 North Bernardo Ave., Mountain View, CA 94043, (415) 960-4040; fax (415) 960-4001.

Circle 1280 on Inquiry Card.



The SPARCard 2 makes a PC a dual-processing workstation.

Dual Emulation Accelerator for LaserJets

A board and cartridge combination, the BetterYet IV dual-emulation accelerator for the Hewlett-Packard LaserJet Series II and LaserJet III provides four distinct performance enhancements for these printers. The accelerator can give you PCL-5 and PostScript emulation at a throughput speed as much as 20 times faster than standard.

When you use BetterYet IV on your network, auto-switching between the emulations is possible. Both emulations provide a 600- by 300-dpi resolution (you need an additional 1 MB of memory in PostScript mode).

Price: $999.

Contact: Output Technology Corp., 2310 North Fancher Rd., Spokane, WA 99212, (800) 468-8788 or (509) 536-0468; fax (509) 533-1280.

Circle 1281 on Inquiry Card.

Super VGA Card Supports Windows 3.1

The WIN.VGA Super VGA card from Video Seven is designed to support Windows 3.1 as well as CAD and DOS-based applications. Available in 512- and 1024-KB versions, the card has hardware-assisted icon (BitBlt) transfers and line draws.

The card supports resolutions of up to 1024 by 768 pixels with 16 and 256 colors in noninterlaced mode and 1280 by 1024 pixels with 16 colors in interlaced mode. The refresh rate at all resolutions is 72 Hz. Video Seven's HT216 graphics controller is on the card, as is a memory-caching mechanism that lets the CPU continuously process data instead of waiting until after the write operation is complete to display memory.

Price: 512-KB version, $199; 1024-KB version, $249.

Contact: Video Seven, Headland Technology, Inc., 46221 Landing Pkwy., Fremont, CA 94538, (415) 623-7857; fax (415) 656-0397.

Circle 1282 on Inquiry Card.

Memory Merges in Your PowerBook

Now you can upgrade your Mac PowerBook by adding to the factory-installed memory rather than replacing it. The flex card from Piiceon is available for all three PowerBook models.

You can upgrade the 2-MB PowerBook 100 and 140 to 8 MB in two ways: You can do it all at once by purchasing a 6-MB upgrade kit or by installing a 4-MB flex card in the vacant memory slot now and adding 2 MB to the card later. To upgrade the 4-MB PowerBook 170, you install the 4-MB flex card in the memory slot and attach the existing 2-MB memory module to the flex card. (The other 2 MB of memory is on the motherboard.)

Price: $395 and up.

Contact: Piiceon, Inc., 1996 Lundy Ave., San Jose, CA 95131, (408) 432-8030; fax (408) 943-1309.

Circle 1283 on Inquiry Card.

Experiment with Fuzzy Logic

A training/development kit that helps you gain familiarity with fuzzy logic is available from American NeuraLogix. The self-contained ADS230 kit includes a PC-compatible board equipped with an NLX230 fuzzy microcontroller that lets you try your hand at developing AI applications. Controlling software and complete documentation are included. Rule-processing time for the NLX230 is 30 to 40 times faster than that of typical software-based or software/hardware combinations, according to the company.

Price: $395.

Contact: American NeuraLogix, Inc., 411 Central Park Dr., Sanford, FL 32771, (407) 322-5608; fax (407) 322-5609.

Circle 1284 on Inquiry Card.

For Complete Inside Information, Place This Card Inside Your Mailbox.

For free information about the FTSA PC, send in this card; FAX this card to 1-713-933-1029; or for immediate attention, call 1-800-627-8700.

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IMPORTANT SPECIFICATIONS: ☐ Data security ☐ Industrial
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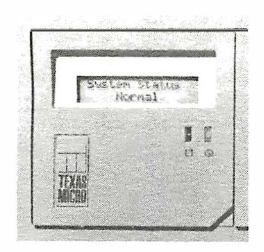
CITY ______________________

STATE ______________ ZIP ______________

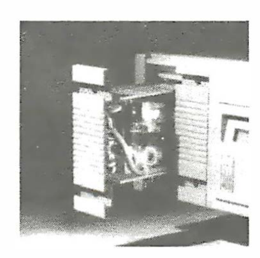
B792

The FTSA PC Lets You Pop It And Swap It.

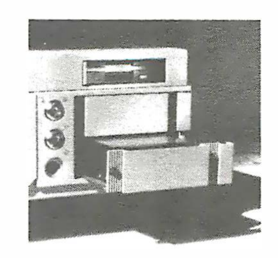
The FTSA PC has a modular design and passive backplane that gives you instant access to components, including the CPU and option cards. And one phone call gives you instant access to all the other information you may need.



The diagnostic system keeps you apprised of power, data and component status.



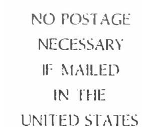
The FTSA PC has two externally-removable power supplies with a built-in backup battery.



A disk array mirrors data to protect you from head crashes.

For FTSA Prices And Configurations Call: 1-800-627-8700.





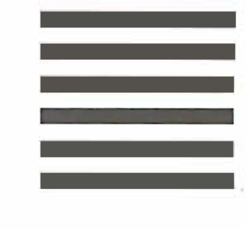
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TEXAS MICRO
10618 ROCKLEY RD.
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The Award-Winning FTSA PC By The Numbers.

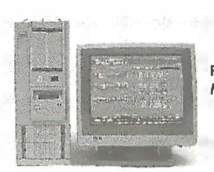
Although the FTSA PC was named Best Desktop PC of Comdex by Byte Magazine, it comes in three different configurations to meet the needs of both desktop and industrial users and everyone in between. Call today for complete configuration information and product specs.



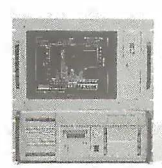
Winner



FTSA Desktop



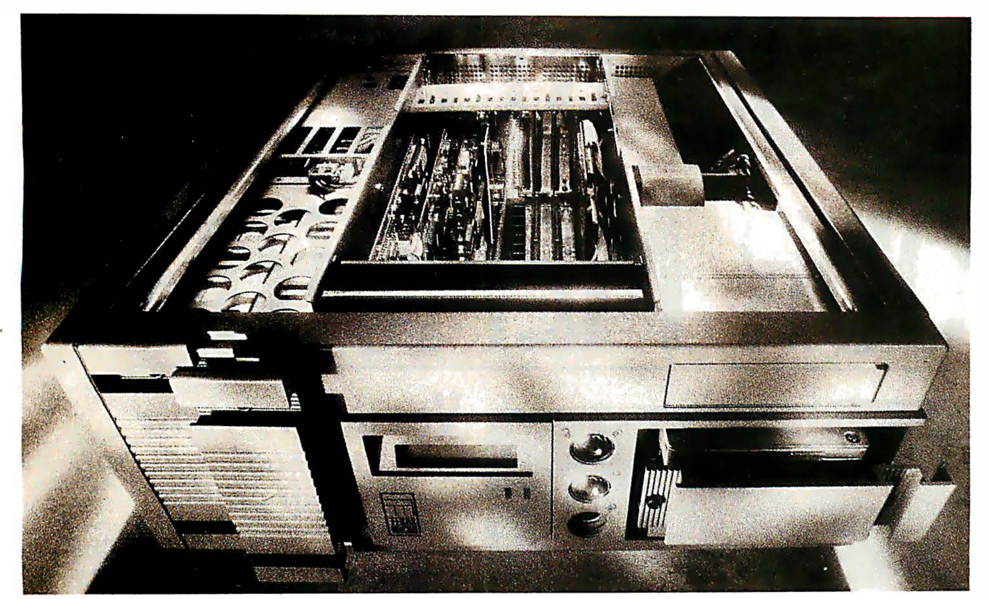
FTSA Micro-tower



FTSA Rackmount

- 8-slot passive backplane
- 386/486 upgradable CPUs
- SCSI hard drives from 80-525 MB
- 1.44 MB floppy
- Up to 1024 x 768
- Redundant power supplies
- Built-in backup batteries

For FTSA Prices And Configurations Call: 1-800-627-8700.



Inside Information On The World's First Fault Tolerant PC.

INTRODUCING THE FAULT TOLERANT PC FROM TEXAS MICRO. If you're someone who has to be on-line, who has to have your data, your PC has arrived.

Head crashes, blackouts, user errors, bad sectors, power surges, jolts, jars, bumps and bruises can't stop it.

It thrives where others knuckle under. It's the pit bull of PC-dom. It's the FTSA™ PC from Texas Micro, and it redefines PC fault tolerance.

THE FTSA PC IS FAULT TOLERANT FROM THE GROUND UP. The FTSA PC is built with a proprietary system of fault tolerance—called Fault Tolerant System Architecture™—that operates at the BIOS level.

This specialized, DOS-compatible BIOS binds the fault tolerant components together, creating an umbrella of fault tolerance, and a level of protection never before achieved in PCs. While maintaining a high standard of performance.

THE FTSA PC KEEPS YOU UP AND RUNNING. The FTSA PC utilizes a backup power supply and self-recharging battery pack to seamlessly stay on-line should normal power fail, while its data mirroring disk array helps prevent downtime due to disk crashes. Its components are monitored by a diagnostic system that will warn you of any impending problem.

This makes FTSA ideal for critical applications like workgroup LANs. In fact, FTSA is compatible with LANtastic and NetWare Lite right out of the box.

THE FTSA PC GIVES YOUR DATA A FIGHTING CHANCE. Supplementing the disk array, the FTSA PC employs sophisticated data auditing and archiving systems that virtually guarantee data integrity, even in the event of a system crash, corruption or unexpected system shutdown.

The FTSA PC's modular design gives you plug-and-play access to every major component, including CPU and option cards, which gives you a 10-minute Mean Time To Repair, and CPU upgradability.

FTSA'S BIGGEST BREAKTHROUGH IS PRICE. In fact, the only thing with comparable fault tolerance is a minicomputer, which costs 5 to 10 times more.

Detailed information about the FTSA PC and our free "Guide to Fault Tolerant Computing" are just a phone call away. Find out today how you can benefit from a PC that has inner strength.

TEXAS MICRO

Get An Insider's Look At The FTSA PC. Call 1-800-627-8700.

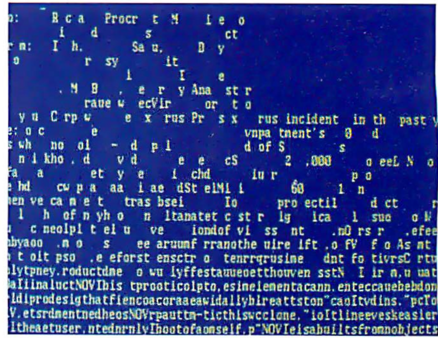
Circle 118 on Inquiry Card.

WILL YOU REMEMBER WHO EATS YOUR MEMORY?

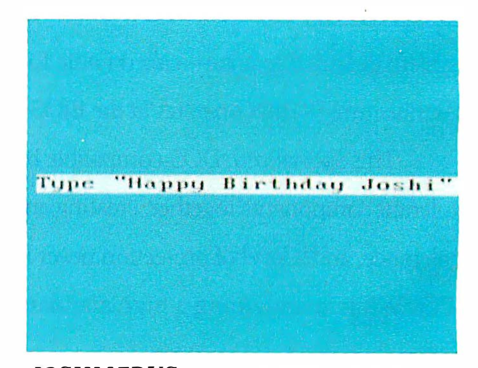


***V**iruses are creative little monsters that can eat up your profits.*

Viruses spread very innocently from normal computer usage. Bulletin boards, hackers and malicious employees are not the problem. Almost 90% of infections come from diskettes, half from data-only diskettes and 3% from shrink-wrapped software. No one is immune. There were nearly 1,000 known viruses in 1991. Between three and five new viruses are created each day. Here are just three examples:



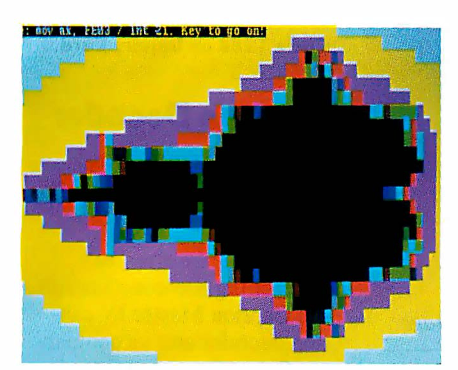
***CASCADE VIRUS.** By the time anyone sees the falling letters, your entire site is likely to be infected.*



***JOSHI VIRUS.** This extremely common stealth virus damages hard drives and about half the floppies it travels on.*

Just remember NOVI™ needs no updates. NOVI prevents or detects and perfectly repairs both known and unknown computer viruses from the moment you install it. NOVI works equally well on single PCs or LANs and is fully Windows™ compatible. Although NOVI can scan for viruses faster than anything else, virus scanning is one thing you can forget about forever. Just let NOVI's patent-pending "Integrity Management" take care of your PCs. There will be no hassles, no maintenance and no user intervention. You can forget about costly and time-consuming updates also, because you won't need them.

THIS AD AFTER A VIRUS

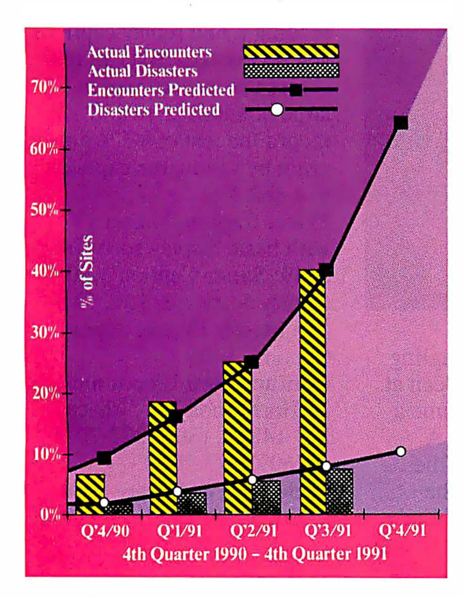


TEQUILA VIRUS. Using advanced anti-scanner and stealth techniques, the virus infects LANs and corrupts hard drives.

Do you think a virus could never happen to you?

Over 60% of American companies and governmental agencies are hit by viruses each quarter. The likelihood of a major virus disaster is doubling every four months.*

*All data from Dataquest/National Computer Security Association virus study (11/91).



Actual and projected percent of organizations experiencing virus disasters each quarter in North America (Dataquest).

How much are your data and downtime worth?

Viruses are no longer someone else's problem, as many businesses have discovered. When a virus hits, it can not only destroy your data and programs, it can also knock out your entire network. A virus puts you off-line until the problem is solved, while it ties up your best people for hours or days. With NOVI, you're always protected and productive.

Designed to work in corporate computing environments.

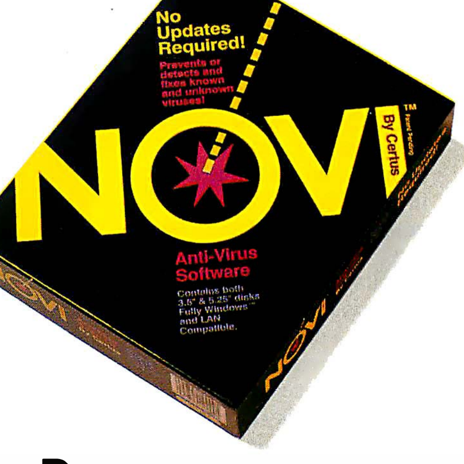
NOVI has no database to maintain, no approval lists, no user updates or maintenance. It produces virtually no false alarms, even when its known-virus features are turned off. NOVI prevents file and system areas from getting infected in the first place. But if an infection occurs, NOVI perfectly repairs it, and returns you to normal operations. NOVI can do all of this automatically and invisibly, without showing a single user message. Or it can be set up to show up to a dozen customizable messages for you and your PC security personnel.

NOVI is the first Object Oriented anti-virus system. You can choose objects and tailor their behavior exactly to the needs of your environment. It occupies from 60 to 600 KB of disk space (with two on-line manuals and a comprehensive virus information base) and as little as 1.6 KB of RAM.

Easy to install, easy to use.

Installing NOVI can be as easy as booting from a NOVI "Clone" diskette or logging onto the LAN – no questions asked. A comprehensive LAN installation can be done under a minute. Logs of virus encounters can be stored locally or sent as a message to a LAN administrator.

Circle 153 on Inquiry Card (RESELLERS: 154).



Pac pricing protects organizations at less cost.

Multiple installation users get significant savings per unit with our unique 10, 25, 50, 100, or 500 pac licenses. This eliminates hundreds of boxes and manuals and provides you with enough licensed software to handle your entire organization or LAN.



Ranked by SOFTWARE DIGEST as the #1 anti-virus program. (Vol. 8.11-1991) "NOVI completely out-classes the other programs with pure speed."

NOVI comes from Certus International, with a five year history of specializing in anti-virus, integrity management and systems management software.

Call 1-800-SAY-NOVI.



certus

Certus International Corporation
6896 West Snowville Road
Brecksville, Ohio 44141 • 216-546-1500

®SOFTWARE DIGEST is a registered trademark of National Software Testing Laboratories, Inc., a Datapro co.

Maintain Real-Time Clock Stability

The ClockMate 913, a 4.5-V alkaline computer clock battery, closely matches the real-time clock in your 286 or 386 computer. Unlike a lithium battery, which has a transitional voltage delay when normal power is lost, the ClockMate 913 ensures continuous voltage above the critical 3-V level necessary to maintain clock stability and configuration file memory. The battery has a nominal capacity of 2000 mA, a temperature range of −30°C to 60°C, an AMP connector, and gold contacts.
Price: $12.
Contact: Plainview Batteries, Inc., 23 Newton Rd., Plainview, NY 11803, (516) 249-2873; fax (516) 249-2876.
Circle 1285 on Inquiry Card.



The ClockMate 913 closely matches real-time clock voltage.

A Spectrum Analyzer for the Mac or PC

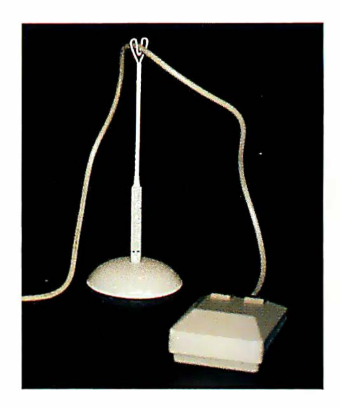
A fast Fourier transform spectrum analyzer that's Mac or PC compatible, the R380 features two channels with 14-bit A/D and software-selectable input signal gain ranges. The software includes modes for a digital oscilloscope, zoom, compare, and save. With a dynamic range of 85 dB, the R380 has a 100-kHz sample rate, 16 KB of data buffer per channel, and up to 8000-point FFT. An external trigger provides remote control; a signal cursor and two dynamic markers let you make spot measurements of voltage, time difference, and frequency.
Price: $1995.
Contact: Rapid Systems, Inc., 433 North 34th St., Seattle, WA 98103, (206) 547-8311; fax (206) 548-0322.
Circle 1286 on Inquiry Card.

Cases for the PowerBook

Compact and Deluxe carrying cases for Mac PowerBook notebook computers have padded handles to make the PowerBooks comfortably portable. A slim, zippered case, the Compact model holds the computer, papers, floppy disks, and pens. An adjustable pad inside helps you custom-fit the case to the PowerBook or other laptop.

In addition to the PowerBook, the Deluxe model has room for such items as a power adapter, a modem, extra batteries, or an external floppy drive. The Deluxe also has a window for your business cards and an outside pocket for keeping plane tickets and newpapers easily accessible. Padded dividers let you custom-fit your laptop.
Price: Compact model, $79.95; Deluxe model, $129.95.
Contact: Kensington Microware, Ltd., 2855 Campus Dr., San Mateo, CA 94403, (800) 535-4242 or (415) 572-2700; fax (415) 572-9675.
Circle 1287 on Inquiry Card.

Eliminate the Mouse Mess



Trying to avoid tangling your mouse cord can at times threaten to become a full-time occupation. A means of eliminating the hassle is available in the Mouse Control. The filled plastic base of the device supports a metal spring, a plastic extension rod, and a top wire holder that elevates your mouse cord, eliminating the frustration of trying to work around it.
Price: $9.95.
Contact: Advanced Image, 2 Route 13 South, Brookline, NH 03033, (603) 673-0212.
Circle 1288 on Inquiry Card.

Caption Decoder Does More Than Decode

If you are involved in teaching someone English, the Caption Master IV caption decoder and its companion Super Caption 3.20 software may be the help you're looking for. The hardware and software combination lets you simultaneously monitor both caption channels on a chosen TV channel. The captions are displayed on your computer screen, enabling you to see the full TV picture at all times.

Since Caption Master IV gets its signal from your TV's video output, the unit is automatically tuned when you tune your TV. Super Caption lets you freeze a caption until you've finished reading it and replay captions you've missed. You can increase the caption size in large or small print and record the text of a TV program by saving the captions to a disk file.
Price: Caption Master IV with basic display software, $149; Super Caption 3.20 display software, $59; Caption Master IV and Super Caption, $169.
Contact: Best Electronics, 30 Hornbrook Rd., Ithaca, NY 14850, (800) 292-7021 or (607) 277-7002.
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MINUTEMAN TAKES CHARGE IN OVER 1000 JCPENNEY STORES.

Every time JCPenney sells a pair of jeans, a toaster or a bottle of perfume, MINUTEMAN takes charge. That's because more than one thousand JCPenney stores rely on MINUTEMAN UPS systems to back up power to their point-of-sale systems.

Every day your company relies on its voice and data communications equipment to stay productive. Unfortunately, the electricity that powers these vital systems is not reliable.

Blackouts, brownouts, spikes, surges and even lightning strikes are common in most business environments. And the high cost of losing vital information and productivity due to power outages and surges calls for preventive measures.

Power requirements can be confusing. And your company has unique needs that often require custom solutions.

MINUTEMAN offers the most comprehensive line of UPS systems available, protecting all your business equipment from stand-alone workstations to the largest of the IBM AS/400s.

MINUTEMAN products are *sold and serviced worldwide*. Call on our skilled professionals to help you determine your exact power protection needs.



MINUTEMAN PRODUCTS

- On-line and standby UPS
- Shutdown software for every available operating system
- 300VA to 10KVA
- Power boost design on the new MINUTEMAN Power Master 600
- Automatic voltage regulators
- International models

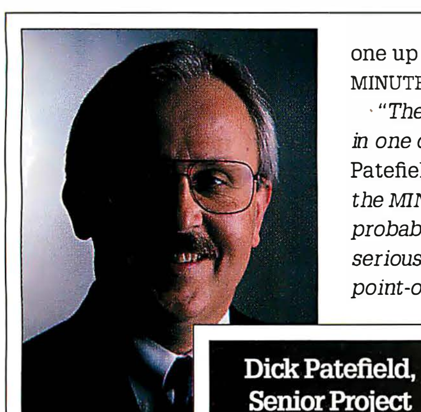
Call our toll-free POWER HOTLINE now for your free Power Protection Guide.

(800) 238-7272

MINUTEMAN®
UNINTERRUPTIBLE POWER SUPPLIES

Reduced prices up to 36%

Call for complete price list.



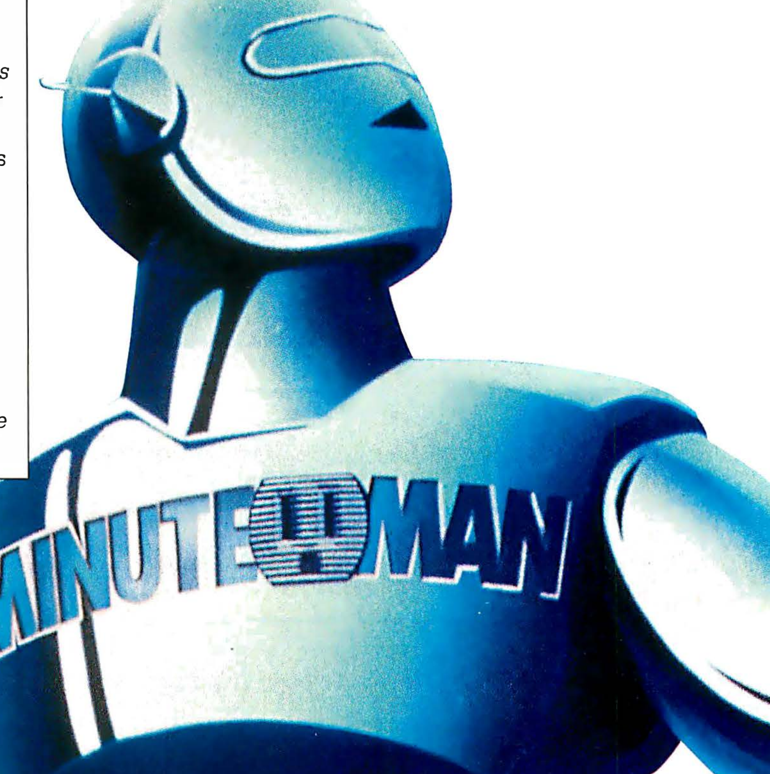
Dick Patefield, Senior Project Manager for Store Systems Support, JCPenney

Recently JCPenney Co., Inc. changed its operations from the old POS systems to the new PC-based technology, relying on PC platforms for point-of-sale and in-store support. And they back each one up with help from MINUTEMAN.

"There was a violent surge in one of our stores," says Patefield. *"If we didn't have the MINUTEMAN unit, it probably would have seriously damaged all of our point-of-sale equipment.*

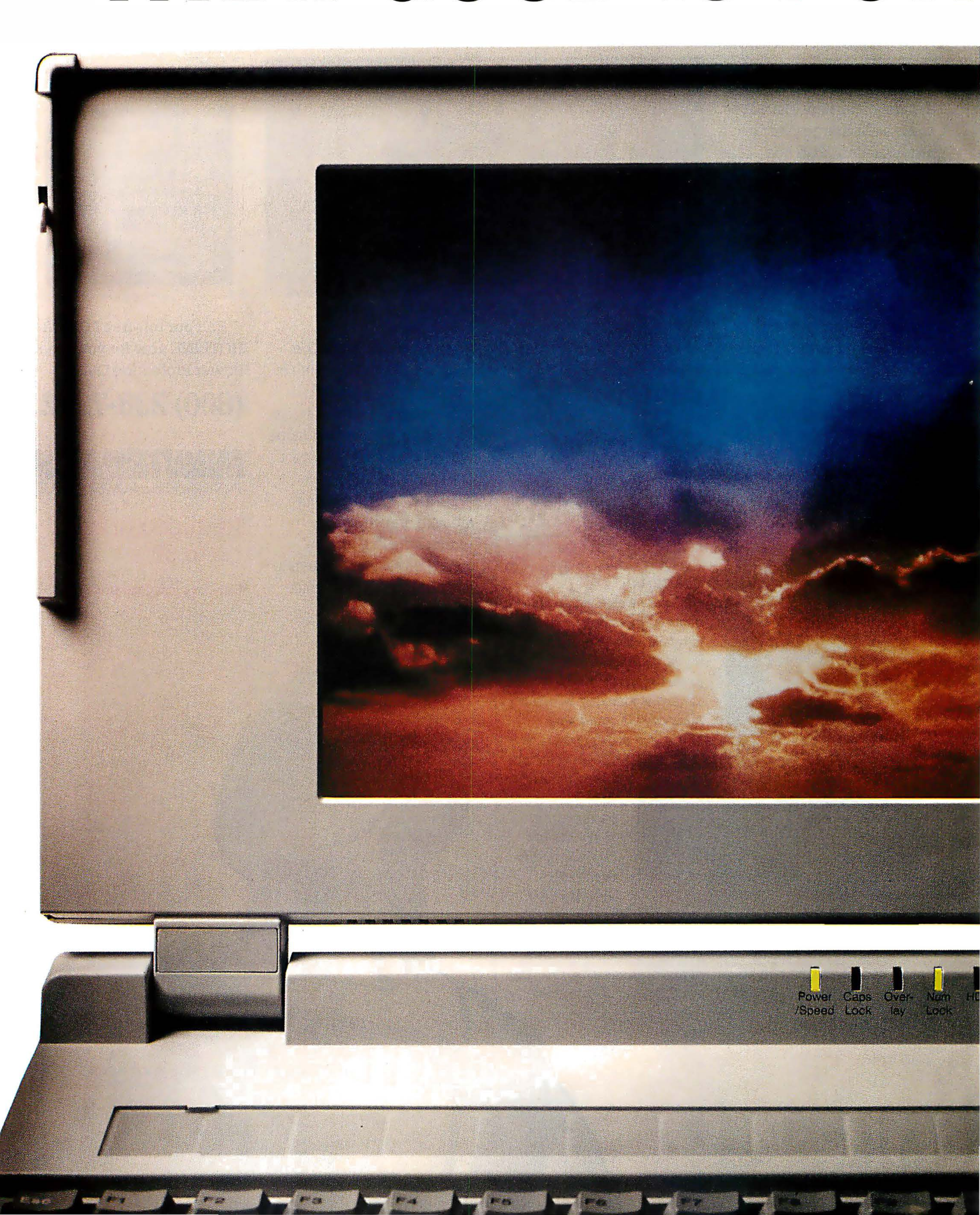
"The key was the switch-over time from AC to battery," says Patefield. *"It really has the best continuity of the UPS systems we evaluated. Also, the price was very favorable. When you're installing them in as many locations as we are, the pricing was very attractive."*

FOR LAN
NOVELL LABS
TESTED AND APPROVED
NetWare Compatible

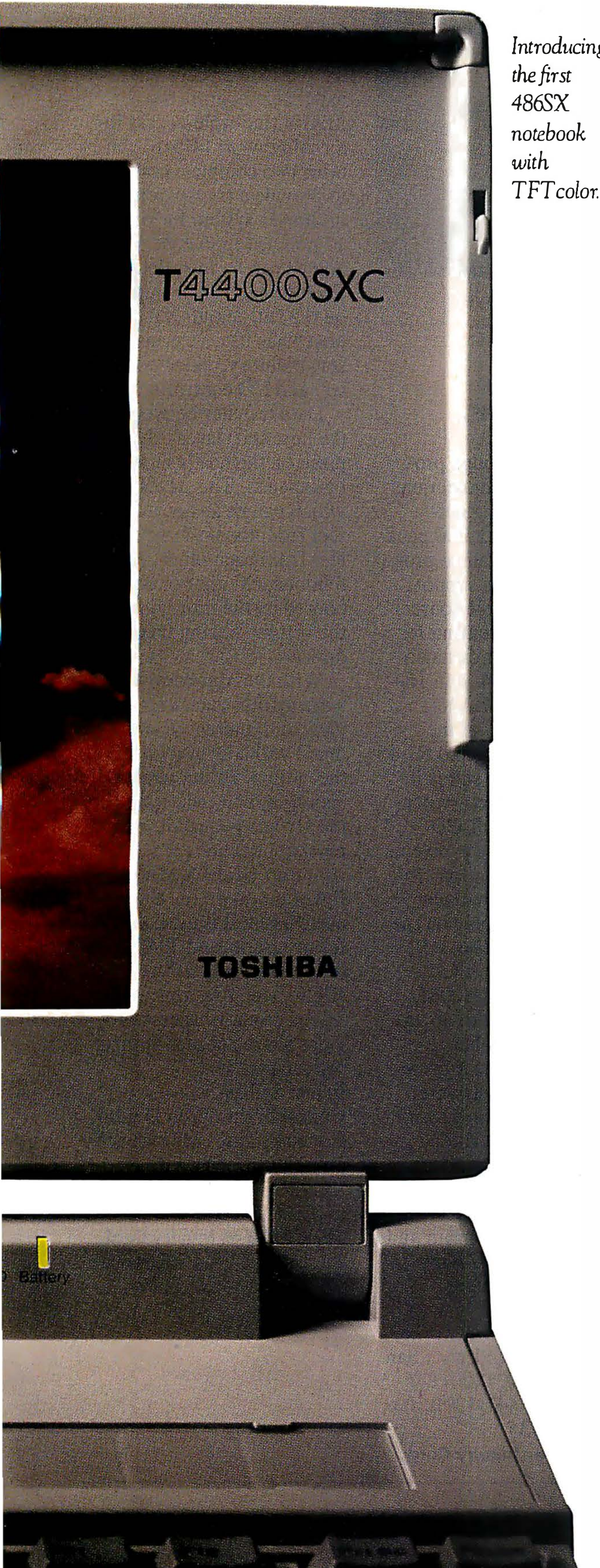


Circle 82 on Inquiry Card.

WHAT GOOD IS POW



ER WITHOUT VISION?



Introducing the first 486SX notebook with TFT color.

You are about to witness an incredible display of power.

Introducing the Toshiba T4400SXC. The first notebook to offer you all the power of a 486SX with all of the jaw-dropping possibilities of TFT LCD active matrix color.

Consider that with its active matrix Super VGA color screen, the T4400SXC can actually display a kaleidoscope of 256 simultaneous colors at a 640 x 480 pixel resolution.

Remarkably, these 256 colors can be drawn from a palette of 185,000 colors to give life to photographic images and color intensive presentations. It's enough to make your retina want to take a vacation.

Not to mention that each pixel on the screen is controlled by three individual transistors, ensuring perfect focus and color registration. The result is amazing clarity far superior to desktop monitors and a brighter, faster screen that far exceeds passive matrix LCD color screens.

Combined with a blazing 25MHz, 486SX microprocessor and 8K internal cache, it's powerful enough to handle your wildest visions.

Of course, you shouldn't be limited by the number of ideas you have either. Which is why the T4400SXC is equipped with a 120MB hard drive for plenty of storage. And 4MB of RAM expandable to 20MB.

And since ideas happen anywhere, any time, we've designed it to fit in half of a briefcase and given it a Nickel Cadmium battery that lasts 3 hours per charge.

Of course, there are times like payday when it is necessary for you to be in the office. Which is why we made our new notebook to be expandable with our Deskstation IV, giving you two expansion slots, and ports for external monitor and external keyboard.

intel inside

Naturally, this is all just the tip of the iceberg, so call us at 1-800-457-7777 for more information.

We think you'll find that when it comes to the future of personal computing, Toshiba has incredible vision.

In Touch with Tomorrow
TOSHIBA

Circle 119 on Inquiry Card.

Gather Data in Real Time

The I/O Station 464 from Strawberry Tree, an Ethernet-based data acquisition device, lets you directly acquire scientific data in real time. Designed for use in applications such as laboratory data collection and industrial process control, the 4¼- by 17- by 16⅞-inch device lets multiple users access data via your network.

You can set up the I/O Station 464 in the lab and access the results in your office, permitting safe acquisition of data during hazardous experiments or processes. The unit accepts plug-in modules with inputs for measuring analog and digital signals, outputs for control, accuracy to 16 bits, and speed to 1 million samples per second. With the I/OStation 464, you can connect your workstation directly to transducers for collecting data for variables such as temperature, pressure, sound, and vibration.
Price: $3995.
Contact: Strawberry Tree, Inc., 160 South Wolfe Rd., Sunnyvale, CA 94086, (408) 736-8800; fax (408) 736-1041.
Circle 1290 on Inquiry Card.

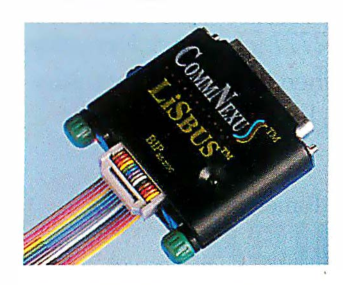


With the I/O Station 464, you can collect data remotely.

Multiple Connections from a COM Port

The LiSBus Async I/O System lets you use your PC as the basis for a master/slave network. From a single COM port, you can address at least 60 devices with serial ports at distances of over 1000 feet; your PC addresses each slave peripheral as if it were the only device connected to the machine. The system includes its own link-control software, which lets you use your current software to communicate with the peripherals.

LiSBus (for linear sequential bus) works through your PC's or peripheral's RS-232 asynchronous communications hardware, using the impedance of the transmission cable and a proprietary addressing system that eliminates the need for explicit binary addresses. All module connections use IDC (insulation displacement connection) technology, and all electronics use surface-mounted components. The system is EMI (electromagnetic interference) resistant.
Price: Starter pack, $650; each additional I/O module, $70.
Contact: Gigatec (USA), Inc., 871 Islington St., P.O. Box 4705, Portsmouth, NH 03802, (800) 945-3002 or (603) 433-2227; fax (603) 433-5552.
Circle 1291 on Inquiry Card.



Smart Connections

Smart Ringbridge provides local connections between token-ring networks as fast as 12,000 packets per second. Able to provide simultaneous support for IBM-compatible source routing and IPX routing for NetWare, the unit can also support a mix of 4- and 16-Mbps token-ring LANs.

The front panel of the unit includes DB-9 and RJ-45 connections, ring-status indicators, ring-speed switches, and a 10-menu LCD that lets you isolate problems and determine solutions for them. The LAN manager sees the same display on the management console. All microcode in the unit is stored in a flash EPROM, which enables you to download microcode enhancements to the bridge after installing the new software.

The unit also comes with user-configurable filters. Software shipped with the bridge includes the standalone DOS text-based Bridge Control Program and the Windows-based RingView Bridge Manager.
Price: $6995.
Contact: Madge Networks, Inc., 42 Airport Pkwy., San Jose, CA 95110, (800) 876-2343 or (408) 441-1300; fax (408) 441-1335.
Circle 1292 on Inquiry Card.

Network on a Board

The banner product of the Maximizer series of expansion boards, the MAIN (multiple-access internal network) Board contains two complete computers to provide a transparent multiuser system for three to 17 people (up to eight boards can be installed). Each 16-bit microcomputer on the full-length XT-size board has its own processor, memory, video controller, and I/O controller.

Data transfer between the host and slaves takes place on the host's bus at bus speeds. The slaves, which can be as far as 250 feet from the host and 500 feet from each other, can reboot each other or be rebooted by the host without the system's being taken down.

With the Mainview software utility, each user can view and interact in text mode with any other user on the system. Print queuing, spooling, and redirecting on the fly lets you print while most applications are still running. Of the 1 MB of RAM on-board for each user, 640 KB is available for programs and 384 KB for the system and buffers. High-speed preemptive interleaved memory access provides shared access without wait states.
Price: $1995.
Contact: Hamilton Digital Controls, Inc., 2118 Beechgrove Place, Utica, NY 13501, (315) 797-2370; fax (315) 797-2309.
Circle 1293 on Inquiry Card.

Your upgrade

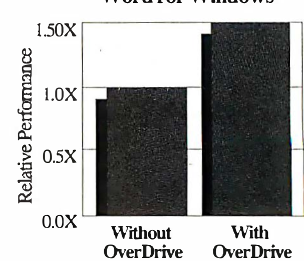
Introducing Intel OverDrive™ Processors.

With built-in upgradability we promised you room for the future. Room for more power.

Well, the future has arrived. Presenting a revolutionary new category of single-chip upgrades: Intel OverDrive Processors. The easiest, most cost-effective way to add even more power to your system–for Intel486™ SX PCs now, and soon for all 486 systems and beyond.

Just pop in a new OverDrive Processor and you'll improve overall i486 SX system





just checked in.

performance by up to 70 percent. Added performance that will benefit over 50,000 compatible software applications.

And that goes for today's demanding Windows software, too.



In fact, by adding an Intel OverDrive Processor, your 486 PC will even run multiple Windows applications faster.

To check in to the OverDrive Processor, see your local computer dealer now.

Or for a detailed brochure, call 1-800-538-3373, ext. 98. And hurry. The vacancies are filling fast.



Circle 63 on Inquiry Card

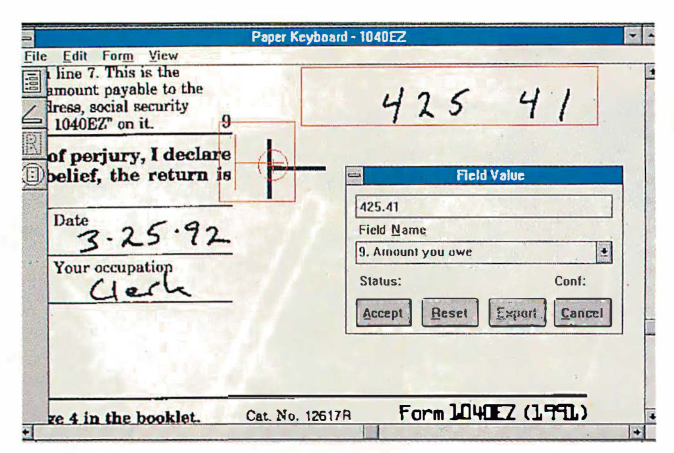
Add Handwriting Recognition to Programs

The developer's version of Paper Keyboard from Datacap lets you use the program's handwriting-recognition and optical-character-recognition capabilities in your own imaging and content-based applications. PKD (Paper Keyboard Dev) allows distribution of run-time versions of the Datacap software and supports Windows' DDE.

PKD is geared toward the software applications publisher and works as a tool that collects and distributes data from scanned forms. After scanning a completed form, you develop a program that saves the scanned data in a database. PKD provides improved handwriting recognition and supports check-box recognition.

Datacap also offers an end-user version of the product. Paper Keyboard ICR (Intelligent Character Recognition) offers all the functionality included in PKD, but without support for run-time versions.

Price: PKD, $4995 plus run-time fees; Paper Keyboard ICR, $3995.
Contact: Datacap, Inc., 580 White Plains Rd., Tarrytown, NY 10591, (914) 332-7515; fax (914) 332-7516.
Circle 1294 on Inquiry Card.



Paper Keyboard's on-screen verification displays the original image and the recognized value for maximum accuracy.

Rational Is Ready for 32-bit Windows

BigWin, announced last summer and available now from Rational Systems, lets you develop 32-bit Windows applications that will run under Windows 3.0, 3.1, and NT (New Technology). The application extender is compatible with 16- or 32-bit DLLs and offers source code compatibility, compiler independence, and zero-based flat model addressing. According to the developer, you can convert 16-bit applications to 32 bits by modifying a make file and rerunning it.

Rational Systems is also shipping its WinServe DOS-to-Windows conversion toolkit. WinServe splits your existing DOS applications into client and server processes; your original application runs under Windows in an invisible DOS session via a front-end program. WinServe provides development tools such as a standard DLL, a built-in debugger, and a Windows 3.0 virtual device driver.

Price: Both products start at $5000.
Contact: Rational Systems, Inc., 220 North Main St., Natick, MA 01760, (508) 653-6006; fax (508) 655-2753.
Circle 1295 on Inquiry Card.

Build Speech Synthesis into Mac Programs

The SBDK (Sound Bytes Developer's Kit) lets you incorporate speech synthesis into new or existing Macintosh applications. The SBDK library uses Emerson & Stern's Sound Bytes text-to-speech synthesis program, which is included in SBDK. The company says that Sound Bytes achieves natural-sounding results by converting entire sentences, not just words. Possible applications for the SBDK include software to access E-mail via telephone or to update public information systems (e.g., train schedules).

The SBDK features a 55,000-word expandable dictionary and can read and synthesize words that are not in its dictionary. You can control your SBDK-based program's pitch range and rate of speech.

Price: $3750, plus run-time license fees.
Contact: Emerson & Stern Associates, Inc., 10150 Sorrento Valley Rd., Suite 210, San Diego, CA 92121, (619) 457-2526; fax (619) 457-1876.
Circle 1296 on Inquiry Card.

Rumba Your Way to Simplified Host Access

RTVB (Rumba Tools for Visual Basic) lets you build GUI-based front ends for mainframe applications running under Windows. You use the program with Wall Data's terminal emulator for 3270 or AS/400 systems and Microsoft's Visual Basic.

RTVB adds custom controls to the Visual Basic Toolbox. The Form Builder feature automatically translates host screens, fields, and functions into Visual Basic forms.

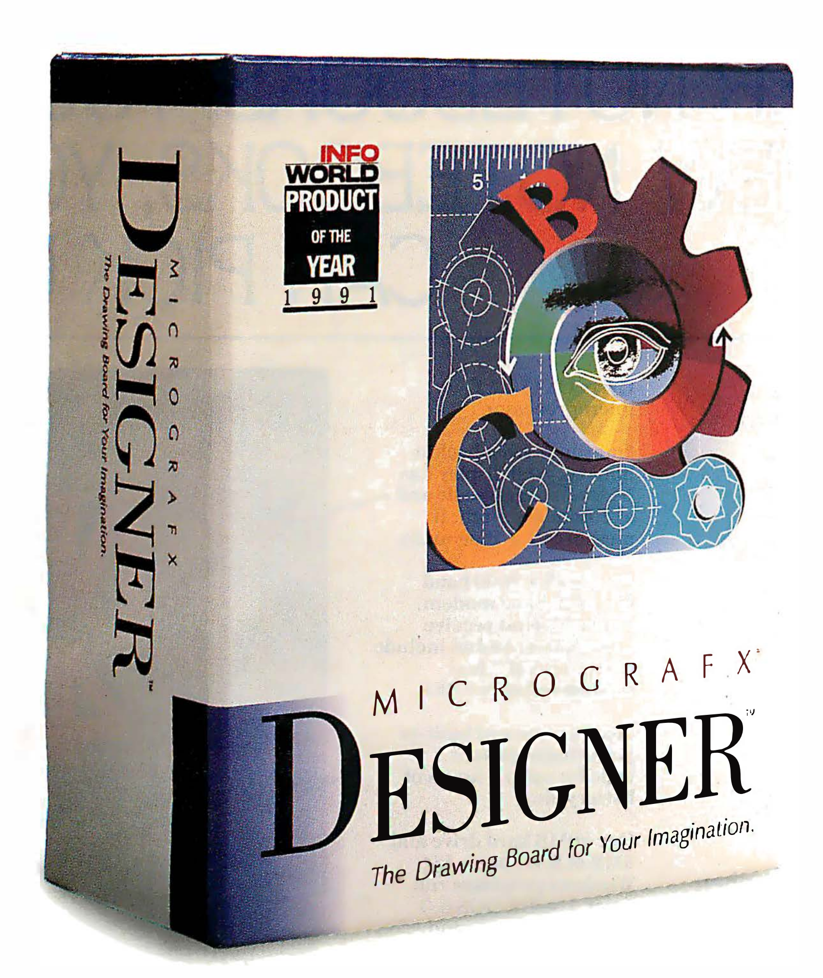
Price: $195.
Contact: Wall Data, Inc., 17769 Northeast 78th Place, Redmond, WA 98052, (206) 883-4777; fax (206) 885-9250.
Circle 1297 on Inquiry Card.

Multimedia Hypertext Authoring

HyperWriter 3.0, the hypermedia and multimedia document-authoring system, lets you merge and link text, graphics, audio, video, and animation within a single document.

Hypertext linking options include cross-referencing and activation of external DOS applications. The system supports DLLs and DDE (both as client and server). You can import text from Microsoft Word and WordPerfect files or import graphics files via .PCX, .GIF, .BMP, and other filters.

Price: $695.
Contact: Ntergaid, Inc., 2490 Black Rock Tpke., Suite 337, Fairfield, CT 06430, (203) 368-0632; fax (203) 334-5658.
Circle 1298 on Inquiry Card.



PRODUCTS OF THE PAST.



PRODUCT OF THE YEAR.

The experts have cast their ballots. And once again, the winner is Designer!

Micrografx Designer™ is the *only* illustration software declared "1991 Product of the Year" by *InfoWorld*. The *only* illustration software named "Editor's Choice" by *PC Magazine* for three straight years. The *only* illustration software to rate five stars from *Software Digest*.

That's because no other software comes *near* the precision drawing power of Designer. With features like multiple layers. Dimensioning. Full-color, full-screen editing. And built-in type-handling software plus 180 Type 1 fonts worth over $5,000!



"New text, blend and color features combine to keep Designer competitive in a fast-moving field. This precise, tool-rich drawing package has its roots in CAD, but it attracts other graphics users as well."

Features	Designer	Corel Draw
Drawing layers	64	1
Dimensioning	Yes	No
Object snap	Yes	No
Maximum drawing size	132"×132"	17"×17"
Edit in full color	Yes	No
Clip art images	Over 1,700	750
Type 1 fonts	180	0
PageMaker 4.0 filter	Yes	No
On line help screens	Yes	No
24-hour support	Yes	No

Move up to Designer now and get 70% off!

If you use Corel Draw or Arts & Letters, call us with your serial number and we'll upgrade you to Micrografx Designer for only $199 (regularly $695) plus $10 shipping and handling. If you're not *blown away* by how much more you can do with Micrografx Designer, return it for a full refund.* This is a limited-time offer, so act now!

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 Micrografx is a registered trademark and Micrografx Designer is a trademark of Micrografx, Inc. All other products are trademarks of their respective owners.
Designer system requirements: 286 (386 recommended) IBM PC or compatible, or PS/2. 1 MB RAM (2 MB RAM recommended). 20MB (or larger) hard disk. Windows 3.0. DOS 3.1 (or higher). Mouse or digitizing pad. Windows-compatible monitor.

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WITH OTHER NOTEBOOKS, YOU G
WITH OUR NEW NOTEBOOKS, YOU
CAN PICK UP

It's no wonder the phones are ringing off the walls at Express. Because our two notebook computers offer exactly what people want–more features than most desktop systems and a choice between our popular 325NXL and our new 425CXL. (Not to mention incredibly affordable prices.)

$2,695
Express 425CXL

Nobody likes to wait.

When you want your data, you want it now. And when you want the next generation in portable computing power, you want that now, too.

Announcing: The end of the wait. Now. Just pick up the phone.

Here's the Express 425CXL, the 25MHz 486 notebook computer that can tackle big spreadsheets, analyze statistics and fine tune your graphics. Anywhere. Anytime. In no time. For only **$2,695.**



Now, a 486 doesn't have to be a big box in your office. Get a 425CXL, and you can have the power you need with you. All the time. When you need it.

The 425CXL features the new Cyrix CX486SLC microprocessor, an affordable and compact chip that's ideal for notebook systems. It's physically smaller than the other 486 chips, so it fits easily into the tight confines of a portable computer. It uses less power than other 486 chips, so your batteries last longer for big jobs. Yet this Cyrix chip delivers 2 to 2.5 times the speed of a 386. And it has a built in cache.

The 425CXL has full coprocessor support–plus all the popular Express features that come with Express notebooks. Its built-in trackball and fax/modem (including free fax and communications software!), 4MB of RAM, 80MB hard drive and the amazing, utility-filled DR DOS 6.0 make using all that 425CXL power a breeze.

Cyrix CX486SLC microprocessor.

Our super-twist backlit liquid crystal display has 64 levels of grayscale and a .30mm dot pitch. It measures 9.4″ diagonally.

We install a 9600 baud fax/2400 baud modem, both with send/receive capabilities. And we include Quick Link II™ fax/modem software FREE.

Sleep button and built-in powermanagement logic for up to 3 hours of battery life.

Our 80MB hard drive and 4MB of RAM mean big Windows programs run great. Use DR DOS 6.0 data compression and your drive can hold up to 160MB!

1.44MB 3.5″ internal floppy drive.

Most notebook microprocessors run at only 16MHz or 20MHz. Ours run at 25MHz.



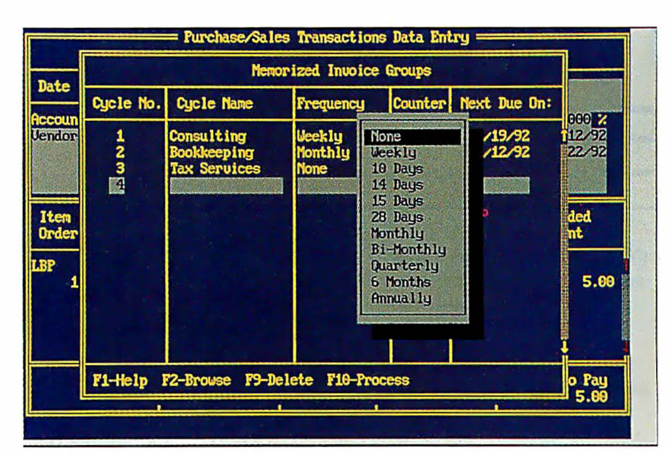
Connect to printers and other peripherals. Each notebook has one RS-232 serial port and one parallel printer port, plus external VGA video, PS/2 mouse and PS/2 keyboard connectors.

Copy and share data with our high density 1.44MB 3.5″ internal floppy drive. An 80MB hard drive and 4MB RAM give you storage and memory for big applications and data.

We accept MasterCard, VISA, money orders, certified checks (please allow ten days for processing), COD's, company and institutional purchase orders (minimum initial purchase $250, thereafter $50 with approved credit) and wire transfers. Shipping charges are calculated according to weight and distance. Texas residents, please add appropriate sales tax. CompuAdd Express will replace or repair defective hardware,

A Wealth of New Features in Pacioli 2000 2.0

Version 2.0 of Pacioli 2000 features faster, improved account entry, a simpler chart of accounts, easier period opening, and support for recurring entries and accruals. Other new features include a consolidated record tool, account-style templates, the ability to import accounting transactions from standard ASCII text files, and support for up to three different taxing authorities.
Price: $49.95.
Contact: M-USA Business Systems, Inc., 15806 Midway Rd., Dallas, TX 75244, (214) 386-6100; fax (214) 404-1957.
Circle 1301 on Inquiry Card.



Pacioli 2000's Memorized Invoice feature lets you set cycles for executing accounting tasks on specific groups of accounts.

PowerPoint 3.0 for Windows 3.1

Fully rewritten to take advantage of Windows 3.1, PPW (PowerPoint for Windows) 3.0 is the only presentation application with full OLE (Object Linking and Embedding) client/server support, says developer Microsoft. Other key Windows 3.1–based features are support for Windows for Pens and 22 TrueType fonts.

The program's auto-outlining and bullet modes guide you in creating a bare-bones text slide. Then you can assign visual characteristics to your raw text using PPW's 150-plus slide templates or your own slide styles. The color palette offers 16.7 million shades, and the product supports 24- and 32-bit color.

PPW lets you preview and import previously designed files, and it comes with graph, draw, and clip-art tools. Once you've created your slides, you can sort and preview the images and transition effects. During an electronic presentation, you can draw on your slides as you display them.
Price: $495.
Contact: Microsoft Corp., 1 Microsoft Way, Redmond, WA 98052, (206) 882-8080; fax (206) 936-7329.
Circle 1299 on Inquiry Card.

Put an End to Blind Searching

Currently available as an add-on to WordPerfect for DOS, UCCM (Utley-Cross Correspondence Manager) automatically organizes and indexes the correspondence on your hard disk. UCCM recognizes date, location, names, sign-offs, and many other syntactical identifiers. UCCM will find "misplaced" text and then let you view, back up, copy, move, edit, or delete it. You can also do full Boolean searches.
Price: $89.
Contact: The Utley-Cross Co., 56A Main St., Suite 130, Maynard, MA 01754, (508) 263-0386.
Circle 1300 on Inquiry Card.

Control File Access and Use via LAN

LAN administrators can use Windows Workstation 4.1 to create a GUI for each network user and customize each user's options depending on his or her needs and access rights. Windows Workstation also lets you perform software monitoring and maintenance. Windows Workstation supports NetWare, LAN Manager, and Vines.
Price: $995 for 10 users; $2495 for 100 users; $4995 for 250 users.
Contact: Automated Design Systems, Inc., 375 Northridge Rd., Suite 270, Atlanta, GA 30350, (404) 394-2552; fax (404) 394-2191.
Circle 1303 on Inquiry Card.

Timeslips Tracks 30,000 Clients

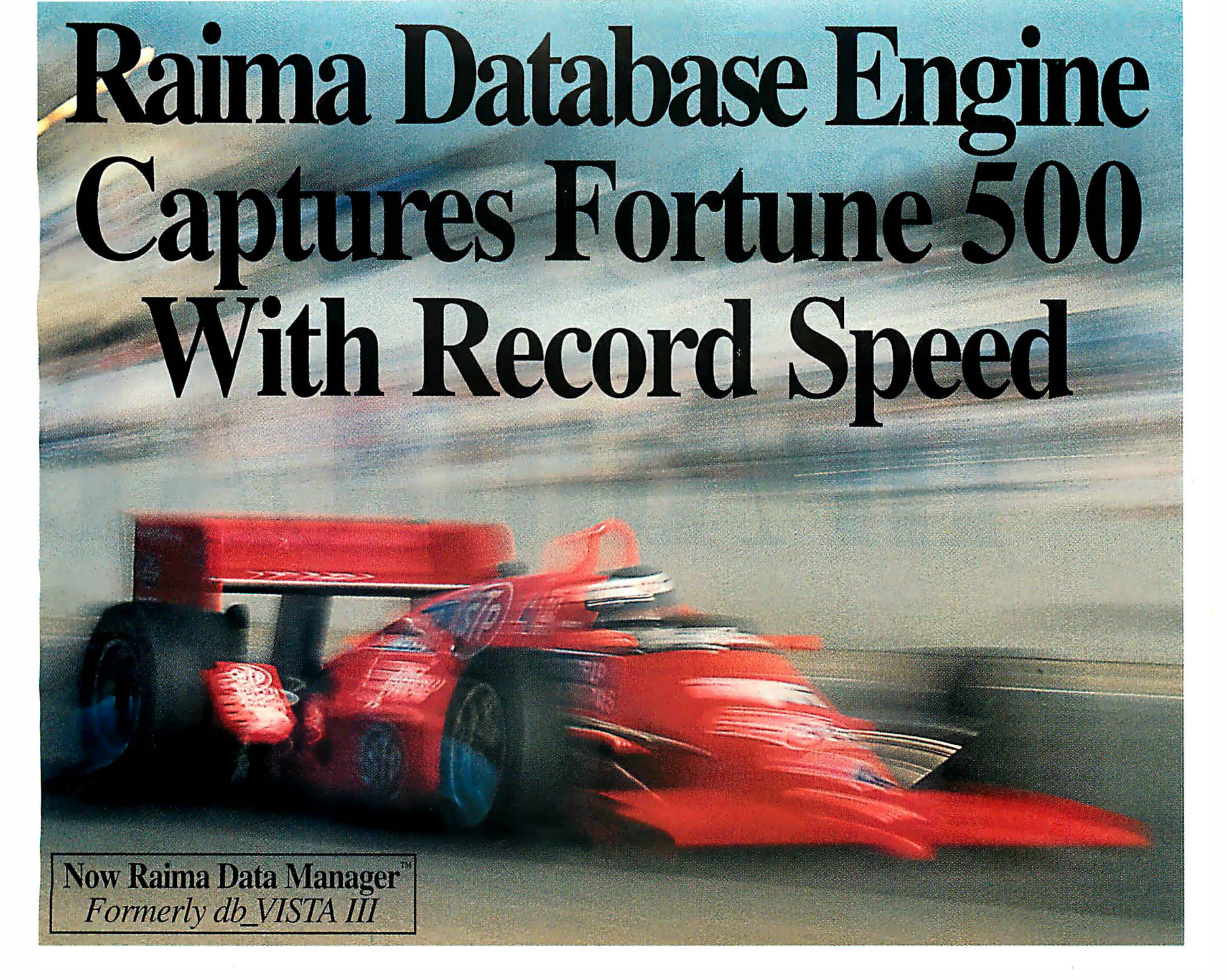
Version 5.0 of the Timeslips time-tracking, billing, and profitability management software for legal, accounting, and other service businesses offers more than 100 new features and improvements, including new report styles and a larger client capacity. Timeslips 5.0 can now keep tabs on 30,000 clients per eight-user program.

New reporting functions let you generate a report on anything that goes on a time slip. You can also monitor the time you spend performing certain tasks and assign up to six billing rates per client. An enhanced import module lets you import ASCII-based files from databases, spreadsheets, Sharp Wizards, and other sources.
Price: $299.95 for eight users; $599.95 for 250 users.
Contact: Timeslips Corp., 239 Western Ave., Essex, MA 01929, (800) 791-0999 or (508) 768-6100; fax (508) 768-7660.
Circle 1302 on Inquiry Card.

Clip Art Gets Down to Business

The SmartPics Windows-based clip-art library is an OLE (Object Linking and Embedding) server intended for use with business applications such as spreadsheets, word processors, and presentation packages. The 38 subject topics comprise over 2100 images.

SmartPics provides customizable installation options, vector and bit-map support, clear gray-scale or linear conversion (for faxing) and support for standard Windows graphics file formats.
Price: Server edition, $195; client editions, $49 each.
Contact: Lotus Development Corp., 55 Cambridge Pkwy., Cambridge, MA 02142, (617) 577-8500.
Circle 1304 on Inquiry Card.



Accelerated Database Performance

Compared to conventional relational databases, retrieval of records can be 10—20—even 50 times faster with Raima Data Manager from Raima Corporation.

Propelling The Biggest Names In Business

Companies like General Motors, Hewlett-Packard, IBM, Eastman Kodak, Rockwell and others are using Raima Data Manager in their competitive environments. Today's most critical, most demanding applications demand the high performance of Raima Data Manager.

Powerfully Efficient Leading-Edge Technology

Raima's combined technology merges the flexibility of relational databases with the lightning speed and efficient storage of the network model. With the program written entirely in C, you can "fine-tune" the Raima Data Manager engine for optimum performance in any application.

Put Yourself In Fast Company

Give yourself the competitive edge of Raima Data Manager:

- Speed—faster access to data
- Portability—supports most environments
- Royalty-free—increase your profits
- Source code availability—total programming flexibility
- Full Raima support services—including training

Whether you're writing a stand-alone DOS application, or one for UNIX accessing thousands of records, Raima Data Manager will put your application on the fast track. Race to the phone and call for more information!

Raima Data Manager™
The High Performance DBMS

In the U.S. or Canada, call: 1-800-DB-RAIMA
In Washington state or international, call: **(206)747-5570**

Specifications Relational B-tree indexing. Network data model. Relational SQL query and report writer. Single & multi-user. Automatic recovery. Built-in referential integrity.
Supports: VMS, QNX, ULTRIX, UNIX System V, Berkeley 4.2, AIX, SunOS, SCO, MS DOS, MS Windows, and OS/2. **Most C Compilers and LANs supported.**

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There Are 174
In AutoCAD

3. Phenomenal 3D rendering. Capabilities that used to come only with AutoShade® are now built into AutoCAD® Release 12. And hidden line removal is up to 100 times faster.

4. AutoCAD SQL Extension (ASE) allows you to access data in standard database management systems via SQL. ASE provides commands for manipulating external nongraphic data and linking it to graphic entities in AutoCAD drawings.

5. Region Modeler creates intelligent 2D models. Allows you to quickly create 2D shapes with holes and complex boundaries. Automatically finds area, perimeter and inertial properties of a region.

6. Automatic timed save at user-selected intervals.

7. Now you can use PostScript® typefaces in AutoCAD drawings.

8. You can also import PostScript files into AutoCAD, and plot them.

9. New boundary polygon command surrounds an area with a closed polyline automatically.

10. New Fence or Polygon window crossing selection feature speeds selection of entities in dense and complex areas of drawings.

11. No Main Menu! You now enter directly into the AutoCAD drawing editor, where you can perform standard file handling and configuration operations, as well as work on your drawing.

12. Dramatically improved entity selection speed in large drawings.

13. Nested entity dimensioning. Entities within blocks or external references are now easily dimensioned.

14. Locked layers feature prevents accidental modification of drawing data.

15. PostScript output feature lets you enhance AutoCAD drawings by using PostScript-compatible imaging programs.

16. Release 12 and Release 11 drawings are forward and backward compatible.

17. Support for 255 individual pen widths for laser and electrostatic plotters.

18. You can plot without leaving the drawing editor. (And without losing the UNDO file.)

19. Now you can import TIFF, GIF and PCX raster images into your drawing.

20. GripEdit feature allows interactive editing of selected entities without running a command.

21. PickFirst feature lets you select entities prior to executing a command.

22. Improved external references. You can attach, reload or bind Xref files while the "master" is being edited.

23. Enhanced hatching. Automatically hatch bounded areas with a single pick.

24. New continuous polyline linetypes facilitate contour mapping and other applications.

25. Programmable dialog boxes can be customized for your particular working environment or by third-party application developers.

26. AutoCAD's new integrated calculator performs calculations based on existing geometry and includes extensive algebraic and geometric functions.

27. New ALIGN command lets you move and rotate entities in 2D or 3D.

28. 3D ROTATE command rotates entities about an arbitrary 3D axis.

29. 3D MIRROR command mirrors entities on an arbitrary 3D plane.

30. CHANGE command enhancements simplify entity property modifications, such as elevation, color, layer, linetype and thickness.

31. Advanced, multipoint tablet calibration allows compensation for map projections or stretched drawings.

32. Platform-independent menus and dialog boxes that follow operating system standards. So AutoCAD works like other programs on your computer.

33. An improved graphical interface makes the power of AutoCAD more accessible to everyone.

34. Cascading pull-down menus that put more power at your fingertips.

35. Pop-up menus at the cursor location for often-used items.

36. Screen menu is automatically updated to reflect the currently running command.

37. Shift and Control key combinations allow you to invoke more commands with your mouse and digitizer buttons.

38. Single mouse click-and-release action for selecting pull-down menus.

39. Automatic Drawing Conversion. Full support for any drawing created by any version of AutoCAD.

40. Enhanced CONFIG command allows for configuring AutoCAD from the drawing editor.

41. New dialog boxes give you control of dimension variables and styles.

42. Dimension dragging feature provides visual feedback while creating dimensions.

43. RECTANGLE command now allows you to create a rectangle with just two screen picks.

44. Enhanced Write Block command helps developers maintain "smart" drawings (entity handles).

45. Enhanced command transparency lets more commands be used inside other commands.

46. Transparent "Object Filters" dialog box allows more flexible definition of selection sets.

47. ZOOM Window is now the default.

48. DXFIX utility reads R12 DXF™ files and translates them into R10 files.

49. New COMPILE command compiles shape files, font files and Type 1 PostScript fonts.

50. Now you can fill closed polylines with PostScript patterns for extremely high-quality output.

51. Network users can view and plot AutoCAD drawings without using server authorization.

52. Database-specific drivers link AutoCAD and external nongraphic databases, such as dBase,® Paradox,® Oracle® and others.

53. Create New Drawing command now allows you to start with an unnamed

New Features Release 12.

drawing or specify a prototype drawing.

54. OPEN command presents "Open File" dialog box to simplify loading of existing drawings.

55. SAVE AS command now changes the current drawing name to new name specified.

56. END and QUIT commands prompt you for a file name when exiting an unnamed drawing, to prevent you from losing data.

57. Several AutoLISP® enhancements, including much faster loading of LISP routines.

58. A wide range of new and enhanced system variables, especially created for the power user.

59. DD Modify command allows for interactive editing of entity parameters.

60. New Units Control dialog box shows all units, angles and direction values on-screen as well as precision settings.

61. New special context-sensitive help dialog boxes allow you to browse through available help files.

62. New View Control dialog box allows selecting with a pick instead of typing in view name.

63. You can plot AutoCAD drawings as bit map files in PCF, TIFF, TGA and GIF formats. You can even automatically FAX your drawings to a subcontractor or client.

64. 24-bit, true color rendering is supported by appropriate hardware.

65. PostScript files can be brought in as outlines or fully rendered images.

66. Modify Entity dialog box enables you to edit an entity's properties directly.

67. Mirrored blocks can now be exploded.

68. List and load standard AutoCAD SHX fonts as well as Adobe Type 1 PostScript fonts from dialog box.

But Either One Of These Alone Makes It Worth The Price.

1. Something every AutoCAD® user has been waiting for: new technology that virtually eliminates regens. A new built-in 32-bit display list permits pans and zooms without regens. So you can spend your time editing your drawing, instead of waiting for regens.

2. The plot quickens. Now you get WYSIWYG plot preview, on-the-fly plot device selection and the ability to save plot configurations.



69. New option allows a box to be drawn around dimension text automatically.

70. Insert a text string before or after dimension text automatically.

71. Configuring for ADI® drivers has never been easier, with the new feature that displays all drivers in the appropriate menu when configuring AutoCAD.

72. HP LaserJet legal-size paper output is now supported by a new, improved device driver.

73. ADS applications can now be compiled by inexpensive "real mode" compilers; no need for costly development tools.

74. AutoLISP and ADS can now be used to drive the PLOT command.

75. Linetype scaling adjusts to view scale in Paper Space.

76–174. Unfortunately, we're out of space. But you get the idea. Release 12 is the most significant enhancement of AutoCAD ever. Its improved performance will pay off for every AutoCAD user. So the cost of an upgrade can pay for itself in a couple of weeks.

If you're still not convinced, call your Authorized AutoCAD Dealer. Your dealer can give you an even more complete list of the new features. And tell you what you need to do to upgrade. If you need more information or the number of your nearest dealer, call

1-800-445-5415, ext. 770.

Outside the U.S. and Canada fax 415-491-8303.

AUTODESK®

Circle 21 on Inquiry Card (RESELLERS: 22).

Speed Up PC Graphics Processing

Touted by its developer as the world's fastest image-editing and photo-retouching program for the PC, PixoFoto 1.1 offers a wide array of graphics effects. The GUI-based program provides drawing, layering, painting, and scanning tools along with 16.7 million colors, direct CMYK editing, and Wacom pressure-sensitive tablet support.

PixoFoto does not run under Windows, although you can import and edit images created within Windows. The program lets you work with 8- to 32-bit images up to 64 MB in size, and it is five to 15 times faster than comparable Windows-based products. You can work with up to 16 different images simultaneously.

PixoFoto supports TIFF, PCX, and other file formats for exporting image files to applications running on both DOS and Mac platforms. A graphics board with a Texas Instruments 340x0 processor is required.
Price: $895.
Contact: PixoArts Corp., 4600 Bohannon Dr., Suite 220, Menlo Park, CA 94025, (415) 323-6592; fax (415) 323-4434.
Circle 1305 on Inquiry Card.



The Pixel Setting controller gives PixoFoto's drawing tools a wide range of fine control. Here, a pastel effect is created using a textured green surface and a randomly speckled custom brush.

SnapPro's Only Limit Is Your Creativity

SnapPro for Windows lets you convert, edit, or preview any image and combine it with images from other formats in a single file. You can convert DOS, OS/2, or Mac files and use them in combination with your Windows images. The developer claims that SnapPro is compatible with the formats used by all popular PC-based word processing, page-layout, and paint programs.

SnapPro's command-button interface guides you through the conversion process. The utility supports 24-bit color, as well as 256-color, 16-color, and black-and-white modes.

Image-editing tools include flip, opaquing, rotation, and masks. You can merge bit maps, vectors, and clip art into a single collage-style image. With the batch preview tool, you can see a thumbnail view of the image without opening each file.
Price: $69.95.
Contact: Window Painters, Ltd., 7275 Bush Lake Rd., Minneapolis, MN 55439, (612) 897-1305; fax (612) 897-3648.
Circle 1306 on Inquiry Card.

HiJaak Moves to Windows

Version 1.0 of HiJaak for Windows supports image conversion of 23 raster formats, 15 vector formats, and 24 fax formats. You can use the program's screen-capture function to save areas as files. By making use of OLE (Object Linking and Embedding), you can use HiJaak to embed nearly any kind of formatted image in your Windows documents. You can also use HiJaak as a DOS screen-capture utility. In addition to conversion capabilities, HiJaak for Windows offers an assortment of image-editing tools.
Price: $249.
Contact: Inset Systems, Inc., 71 Commerce Dr., Brookfield, CT 06804, (800) 828-8088 or (203) 740-2400; fax (203) 775-5634.
Circle 1307 on Inquiry Card.

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Understand Many Languages in a Flash

Transparent Language for the Mac teaches you foreign languages by presenting literature in French, German, Spanish, or Latin. As you read the foreign text, you can click on individual words or sentences to see a context-based English translation. The basic package comes with four works of foreign literature (one in each language) and audiotapes for improving comprehension and pronunciation.
Price: $115.
Contact: Transparent Language, Inc., 9 Ash St., P.O. Box 575, Hollis, NH 03049, (800) 752-1767 or (603) 465-2230; fax (603) 465-2779.
Circle 1308 on Inquiry Card.

Desktop Publishing for the Rest of Us

PFS:Publisher for Windows is a full-featured desktop publishing package aimed at users in small businesses. When working in Publisher, you have to choose between text (writing) and object (layout) mode. You can set up your own text frames or use the included templates to design a page.

Other features include style dictation, text wrapping, OLE client status, and a spelling checker and thesaurus. Supported word processors include WordPerfect, WordStar, and Ami Pro.
Price: $149.
Contact: Spinnaker Software Corp., 201 Broadway, Cambridge, MA 02139, (617) 494-1200; fax (617) 494-1219.
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IN 1980, WE INVENTED A NEW WAY TO SAVE YOUR FILES.
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Micro Floppydisk
Single Sided

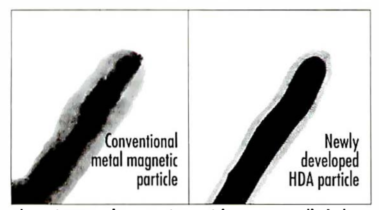
IN 1992, WE'RE INVENTING NEW WAYS TO SAVE YOUR BUSINESS.





KEEP YOUR BUSINESS MOVING FORWARD BY BACKING UP.

While the information revolution brought great advances, it also brought great anxiety.



These improved magnetic particles can actually help hold your business together.

Like knowing your company could be exposed to a loss from which it may never recover.

The loss of vital information, the lifeblood of your business.

Because in today's computerized office, valuable files that you've created over the years can be lost in mere seconds.

All it takes is a slip on the delete key. A sudden power failure. A quick-spreading virus. Or, the ultimate disaster — hard disk failure.

Every bit and byte of information your business runs on can be suddenly wiped out. Critical data that can cost thousands of dollars and hundreds of hours to replace.

If it can be replaced at all.

To counter all your new found worries, Sony has a number of reassuring options for you.

Read on, or risk having your business left behind.

A SAVINGS PLAN FOR PRICELESS DATA.

It all began back in 1980 when we introduced the 3.5 inch floppy disk.

For the first time, hundreds of cumbersome pages could be preserved on one space-saving disk.

A graphic demonstration of the need for high capacity data storage.

A disk that quickly became the industry standard.

Today, we're evolving equally innovative data storage products to help your business grow.

We took a long, hard look at what computer users need today. At personal computer users, workstation users and LAN users. And at what businesses are likely to need way into the future.

Then we created a whole new generation of data media. From more versatile floppy disks and higher-capacity data cartridges to faster-access rewritable optical disks. All designed to provide the most efficient data storage and retrieval for businesses of all sizes.

FLOPPY DISKS FOR TODAY'S MOVERS AND SHAKERS.

Twelve years after inventing the 3.5 inch floppy disk, we're still further perfecting it.

Our new XT series of floppy disks is designed for the way people use computers today. And where they use them.

These new disks have a smoother surface which drastically reduces friction between the disk and the drive.

The result is the fewest read and write errors ever. And because 20% less power is needed to run the drive, they easily cope with the harsh demands of portable and laptop computing.

The 2 megabyte XT floppy has a new, reinforced layer to protect your data from scratches and dust. Making these disks ideal for businesses on the go.

INVEST IN PRECIOUS METALS.

In business, nothing is more precious than data preservation. Except, perhaps, self-preservation.

Fortunately, over 30 years ago, Sony discovered the benefits of metal tape technology for high-density recording.

Today, you can see the rewards of our efforts in our 8mm and 4mm data cartridges. Highly advanced metal tape technology that provides even longer-term stability.



A 5 gigabyte 8mm data cartridge can store a stack of papers 30 stories high, leaving more room for your business to grow.

8MM DATA CARTRIDGES. DESIGNED TO SAVE YOUR DATA, NOT YOUR BIRTHDAYS.

We weren't satisfied to just invent the 8mm video recording format.

So to meet the need for improved data integrity, we developed an enhanced data

grade 8mm cartridge for quick, safe, reliable backup.

Our enhanced data grade D8 holds a staggering 5 gigabytes of information (roughly equal to 7,000 standard floppy disks).

You'll find safety features never conceived for video grade 8mm tape, offering drastically improved durability. And a shelf life in excess of 30 years under recommended conditions.

For today's most demanding data storage and backup applications, Sony D8 cartridges are designed to give your business a memory worth celebrating.



DDS 4MM DATA CARTRIDGES. ADVANCED BACKUP IN A COMPACT FORMAT.

The 4mm DDS data cartridges use Sony's advanced DAT technology.

Not to make music, but to store the data that keeps your business humming.

This highly advanced format was developed along with Hewlett Packard.

It results in an incredibly compact DDS cartridge that can handle up to 2 gigabytes of data, while providing maximum security for all your vital storage and archival needs for years to come.

Somehow, we thought you'd like the sound of that.

1/4 INCH BACKUP FOR A SAFER WORKPLACE.

Sony QD series data cartridges are designed to keep your data protected from any potential accidents.

The versatile 1/4 inch cartridges come in a variety of standards and offer superior error-free recording and easy to use convenience across a wide range of applications.

Thanks to our ongoing improvements, tape drop-out has been greatly reduced, while tape speed fluctuations are a thing of the past.

There's even the new QD 9135 data cartridge with a 1.35 gigabyte capacity. Giving data-dependent businesses all the room they need to grow.

REWRITABLE OPTICAL DISKS HELP YOUR VISION EVOLVE IN A WHOLE NEW WAY.

As the leader in optical technology, only Sony designs and manufactures both 5.25 inch and 3.5 inch rewritable optical media and drives.



Our 5.25" rewritable optical disk is breaking all jukebox records.

So it stands to reason we understand the technology better than anyone else. Our 5.25 inch rewritable optical disks can sustain 10 million erase/read/write cycles, ensuring long-term data integrity. While in an optical jukebox, these highly durable disks can cope with countless loads and unloads.

And by offering the first 30 year warranty, Sony continues to write new standards for optical media.

We've also put a new spin on 3.5 inch rewritable optical media with disks that perform equally well in all 1800 — 3600 rpm ISO standard drives. Providing a new level in media interchangeability.

Durability, direct accessibility and portability make Sony rewritable optical disks the ideal storage media for forward-looking businesses.

WE LEAD, THEY FOLLOW.

At Sony, we're committed to inventing new formats and perfecting new standards in data media to meet changing business needs.

As new computers and new applications are developed, Sony will be developing new data media products that will hold even more information, more securely.

And we'll continue to explore the limits of data recording technology.

After all, inventing new ways of saving your business is our business.

For more information on Sony Data Media products, please call (201) 930-7025.

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FREE PRODUCT INFORMATION

Mail Your Completed Card Today. For Quicker Response, Fax to 1-413-637-4343!

Circle the numbers on Inquiry Card which correspond to inquiry numbers assigned to items of interest to you.

Check all the appropriate answers to questions "A" through "E".

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A. What is your primary job function/principal area of responsibility? (Check one.)

1 ☐ MIS/DP
2 ☐ Programmer/Systems Analyst
3 ☐ Administration/Management
4 ☐ Sales/Marketing
5 ☐ Engineer/Scientist
6 ☐ Other

B. What is your level of management responsibility?

7 ☐ Senior-level
8 ☐ Middle-level
9 ☐ Professional

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?

10 ☐ Yes
11 ☐ No

D. What operating systems are you currently using? (Check all that apply.)

12 ☐ PC/MS-DOS
13 ☐ DOS + Windows
14 ☐ OS/2
15 ☐ UNIX
16 ☐ MacOS
17 ☐ VAX/VMS

E. For how many people do you *influence* the purchase of hardware or software?

18 ☐ 1-25
19 ☐ 26-50
20 ☐ 51-99
21 ☐ 100 or more

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Inquiry Numbers 1-493

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Inquiry Numbers 987-1479

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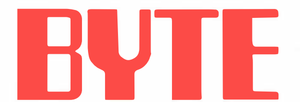


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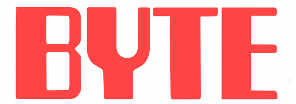






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Inquiry Numbers 1-493

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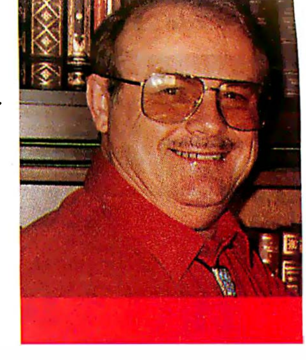
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USER'S COLUMN



JERRY POURNELLE

Computer Ferment

I'm at the Spring Comdex/Windows World shows now, but I started this at home. Out there in the rest of the world, the economic recovery continues to falter for reasons I'll get to in a minute, but you'd never know that from looking at the Comdex ferment. Really good software and hardware products are all over. It was that way at home, too, with so much good stuff coming in that there's no possible way I can get to everything. This means that many things I'll mention this month won't get anything like the attention they deserve. I'm afraid there's no help for it.

Operating Environments

If you're still running a 286 or older system and you're happy with it, you can ignore this advice. But if you have a more modern system, it's time to upgrade. I've gone to DOS 5.0 and Windows 3.1, and I advise you to do the same. I won't get to much of it this month, but there's a lot of exciting new Windows software at Comdex, and more is coming all the time.

A few cautions. First, Windows 3.1 is stable, but it isn't *really* meant for multitasking. About the only programs I let run in the background are communications programs, and for those you're better off getting an Intel Satisfaxtion board, with its on-board coprocessor. Why steal CPU cycles from yourself? Windows is a nifty task switcher for both DOS and Windows applications, and that's enough reason to change over.

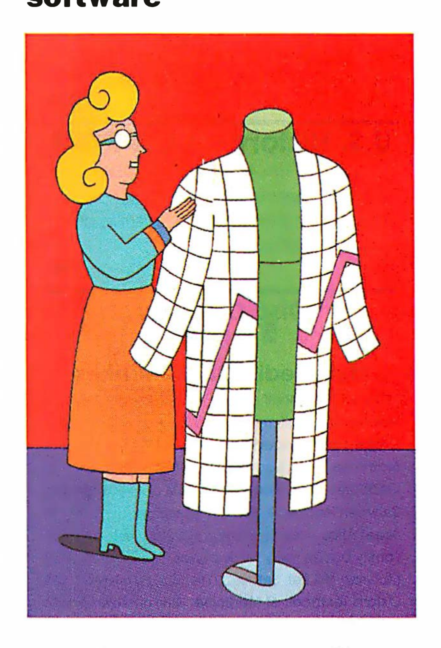
Of course, you *can* run tasks in the background. At the moment I'm not using the Satisfaxtion board, and I can report that Norton Commander (which gets my MCI Mail), Aladdin (which is the front end for communicating with GEnie), and Procomm Plus (which I use for BIX and all my routine communications, including big XMODEM and ZMODEM downloads) all run in Windows background provided that you set each up with a PIF (program information file) and give them a goodly share of background cycles. I'll have more on PIFs in another column.

Second, if you go to Windows, you *must* get a fast video board; it's agony without one. I currently recommend boards from Sota Technology, ATI Technologies, Video Seven, and STB Systems. I'm sure there are other good ones, but those are the ones I've used.

Third, everyone reports some goofiness with sound boards. We can play Microprose's Civilization on either of our Cheetah systems; they're identical except that one runs at 25 MHz and the other at 33 MHz. However, on the 33-MHz system under Windows the game is erratic and the Sound Blaster Pro board doesn't work. On the 25-MHz system the game plays reliably under Windows, but sometimes it s-l-o-w-s down for no apparent reason; when it does, so does the sound. Outside Windows, the game plays fast enough that there's no measurable difference in performance between the two machines, and Sound Blaster Pro works fine with both.

Windows developers tell me that Windows 3.1 requires new drivers for a number of peripherals, and we'll have them Real Soon Now. Meanwhile, none of the games I have will play under Desqview, so the fact that they don't do well under Windows isn't all that annoying. I've been collecting new sound boards and drivers at Comdex, and I expect I'll have more to report next month.

Jerry looks at the latest in a raft of hardware and Windows-based software



In case anyone is wondering: we use complex games to test Windows/DOS compatibility for the same reason that Flight Simulator used to be *the* test for PC compatibility.

Norton Desktop for Windows 2.0

Norton Desktop for Windows was a necessity with Windows 3.0. However, Windows 3.1 is greatly improved, with enough new features that Microsoft would have been justified in calling it version 4.0. For instance, the file manager lets you drag and drop files or whole folders and will kill directory trees. There are many other improvements. You can do just fine with version 3.1.

On the other hand, Norton Desktop for Windows has a lot of conveniences, such as nested filenames, good batch capability, and a way to pack often-used icons into a "toolbox" that saves desk space. It also brings in Norton Disk Doctor and Disk Editor; it has a "smart erase" that keeps erased files recoverable, an icon editor, and a whole bunch of stuff.

I've got it on one system, and I run Windows 3.1 "bare" on another. While Norton Desktop for Windows

ILLUSTRATION: STEVE TURK © 1992

is convenient, I don't miss it much when I don't have it. That could change as I get used to it. Fortunately, Symantec has sped it up considerably: it used to be you could go take a shower while it loaded.

Norton Desktop for Windows incorporates several features from Norton Commander. Although that's convenient, Commander—including the MCI Mail interface—runs just fine as a DOS program under Windows, and I use it.

The one thing I do *not* recommend is using Norton Desktop Backup with floppy disks. Norton Desktop for Windows will do a backup to tape, and that's good, but I have several reports of unreliability in backups to floppy disks, including an inability to read disks it has created. Clearly, you need a good backup system, but if it does not run fast and conveniently, you won't use it; and no backup to floppy disks is either fast or convenient.

My recommendation is that you get a WORM or optical drive if you can afford it; otherwise, get a Colorado Memory Systems tape drive. Whatever you get, use it regularly. Norton Desktop for Windows can help with that: it has an automated batch-file capability, meaning that you can write a backup batch file and have it execute in the dead of night. Of course, the ultimate backup system is DAT (digital audiotape), which costs about a penny a megabyte for storage media, and the Palindrome backup management system.

I'm still experimenting with Norton Desktop for Windows; maybe I'll learn I can't live without it. Symantec has also announced a Norton Desktop for DOS, but I don't have it yet.

The Modem World

I like USRobotics modems. They're simple and reliable. The school I gave my first one to still uses it daily, and that's six years now. When I get a new USRobotics modem, I have absolutely no problem setting it up. I set the external switches on the back, plug it in, and that's that. I never look at the manual, because all you need, including the switch settings, is stenciled on the bottom of the modem itself. I have no hesitation about recommending USRobotics products.

We recently got two of Supra's new high-end modems: the Supra Fax Modem and the Supra Fax Modem V.32bis. They're little things, about one-fourth the size of the USRobotics modems.

Roberta used the Fax Modem to connect to a Mac. The modem came bundled with Microphone II. The modem was fine, but the Microphone II instructions weren't clear. Roberta had no trouble with the modem itself, but we had to get help with Microphone II. Fortunately, Supra's technical-support people are very good, and the Fax Modem and Microphone II are now working fine on her Mac.

As for the Fax Modem V.32bis, I opened the box, unplugged the USRobotics modem, and plugged in the Supra modem in its place. That's it. So far it has worked to connect to BIX using Procomm Plus, GEnie using Aladdin, and MCI Mail using Norton Commander. More next month. Recommended.

Autobook: ADA 2.0

This is a good program, but I wish I didn't have to review it. Autobook: ADA is an electronic indexed edition of the full text of the Americans with Disabilities Act. It also has an editor, which lets you bring in portions of the text and write comments. The commented text is then saved in a different file; the original isn't changed.

Incidentally, this practice was known in medieval times as "writing a gloss" on the text. In those days paper was very scarce, and critics would write comments between the lines and in the margins of a parchment text. Eventually, there might be so many comments that the original had essentially vanished—it had been "glossed over" in the vernacular of the time. This is also the origin of the word *glossary.*

The Autobook indexing system is excellent: it will find not only the words you ask it for, but many that are properly related. It will find *explosive* and *explosion* if you're looking for *explode*; but it won't show *exploit*, as a search on *explo** would. It's a great deal more useful than a paper index.

Finally, Autobook understands the paragraph- and section-numbering conventions used by the Act, and thus it can find cross-references more quickly than all but expert human users could.

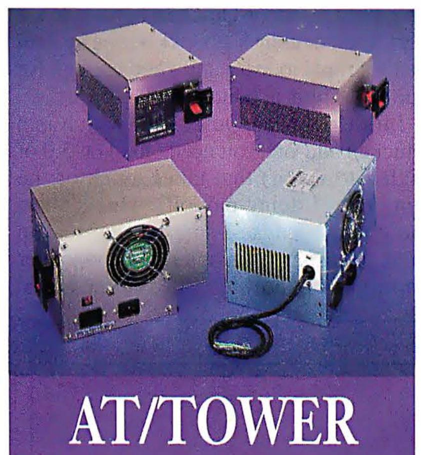
All told, then, if you're involved with compliance with the Americans with Disabilities Act, you probably need this program; and if you're in business, you're likely to be affected by the Act.

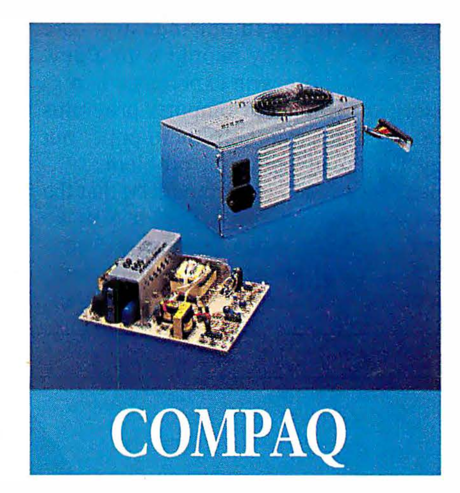
And that's a shame. There may be an argument for federally mandated programs acting on private businesses, although when I was a lad it was thought obvious this sort of thing was the province of the states; but I don't know of any economist who believes that imposing very expensive new regulations during a recession is wise. Our major industries are downsizing, and many are moving their operations offshore, precisely because of the rising regulatory costs in the U.S.

Worse, most new jobs come from small businesses, and they are the ones most harmed by complex regulations and least

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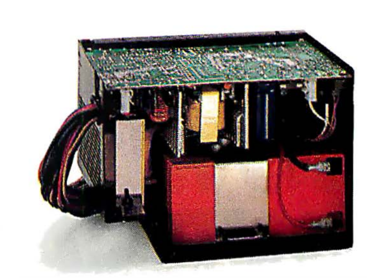
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able to deal with them. Start-up companies—particularly in our industry—are usually managed by people with a new idea, not by those with experience in regulatory compliance. Computer programs like Autobook can help them cope, but they don't really solve the problem.

I am more and more convinced that the increased productivity computers make possible is being eaten by increased government regulation, so more work is done, but no more wealth is created. So it goes.

QuickPay 2.0

I've written about Quicken before. It's a very good beginner's bookkeeping system that's simple to learn and good enough for quite complex accounts.

Intuit now has QuickPay, which is a Quicken add-on (you need Quicken 3.0 or higher to use it) that takes much of the sting out of doing payrolls. That's all to the good, because I suspect one reason more people aren't hiring is they no longer know how. I know it's true for me: I used to have a few part-time people working for me, but when the man who did the payroll stuff quit at a time when I didn't have any other employees, I never replaced him or hired anyone else. If I need assistance now, I just contract it out; it's simpler. If I ever do take on new employees, I'll certainly use QuickPay. Recommended.

Word Processors

I have installed three new word processors for Windows: Lotus Write 2.0 (which used to be known as Ami 1.2), WordStar for Windows, and Microsoft Word for Windows 2.0.

Let me summarize quickly. I'm writing this using Q&A Write, a DOS program running under Windows. If I needed precise formatting or graphs or drawings pasted in, I'd have to use something else. But even then I'd be tempted to write the first draft with Q&A Write or another character-based editor and bring it to a Windows word processor for the fancy stuff.

The problem with all the Windows word processors I've tried is they do too much. There's a lot of busy stuff on-screen; some I can get rid of and some I can't. I suppose I could learn to live with that. They display black letters on a white background, while I'm used to white on blue, but I work with black on white on laptops and get used to it. For that matter, I can use the Windows control panel to adjust the colors.

What I can't get used to is the way the letters jump around on the screen. That won't bother anyone but a touch-typist, but for someone who looks at the screen while typing, it can be very annoying that the letters change shape or rearrange themselves as you type.

There are other problems. A lot of my friends recommend Lotus Write, but I found that it has a lot of trouble converting documents. If they're anything but plain-vanilla text, you'll probably have to run them through Word for Word before importing them. I never did get a Microsoft Word for Windows bullet-style report to go into Lotus Write. I expect if I'd been desperate I would have found a way, but Lotus Write is also the worst of the "word jumpers"; I don't see how anyone can watch the screen while typing with it. Of course, a lot of writers never do watch the screen as they type, and by the time they look up, the words have done their dance.

Of the three Windows programs I tried this week, Microsoft Word is the least annoying, and it seems to have all the features anyone would ever need. I used it to create a neatly formatted bullet-paragraph report for the National Space Council—sometimes you really need WYSIWYG—

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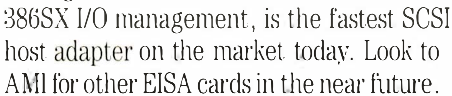
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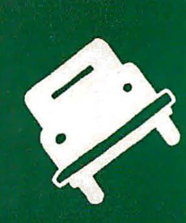
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and Microsoft Word did that splendidly. The spelling checker is fast and easy to use. I also got used to some of the editing features, and when I'm editing, I like using the mouse. However, I wish I had a way to turn off all the proportional-font stuff and just type 60-column lines when I'm doing creative work. I can come close to that with Microsoft Word for Windows and the Arial typeface, and maybe I'll get used to it. We'll see.

End Note Plus

One reason to adopt a "standard" word processor such as Microsoft Word or WordPerfect is the specialized programs written for them. End Note Plus from Niles & Associates is a bibliography tool. The new version works with the Windows versions of Word and WordPerfect; there's also a DOS version. End Note Plus will let you build an enormous database of annotated citations. You can search and sort and abbreviate or expand abbreviations. You put them in your paper as you write it and then let End Note Plus do its thing. It goes through your document, makes all your citations in a consistent style, and puts the bibliography at the end. It knows most standard citation styles, including those used by *Science*, *Nature*, and the Modern Language Association.

It works, the interface is quite good—the program migrated from the Mac—and it's simple to learn. This is the kind of thing that if you need it, you need it badly; it can save hours in scholarly or scientific paper preparation. Recommended.

Incidentally, the same company also publishes Grant Manager, a software accounting system; if you do science management, you ought to get their catalog.

CompareRite

CompareRite is another useful tool. It supports WordPerfect (which seems to have become nearly standard for lawyers), XyWrite, WordStar, ASCII, and Ami/Lotus Write. The version I have isn't aware of Windows or the Windows versions of those programs, but I'm sure Jurisoft will have a Windows version shortly.

As its name implies, CompareRite compares versions of documents. It works. I've used one or another version for years. It's especially useful when Niven and I work on a novel and forget which is the latest version, or, worse, when we inadvertently work on the same chapter simultaneously. Recommended.

Lexica

I mostly just want to make you aware of Lexica. It's a multilanguage dictionary/thesaurus, offering choices in French, German, Spanish, English, and Dutch. It follows WordStar's International Correct Grammar program, which I'll have to try sometime. It works with several standard word processors, including, of course, WordStar.

I'm not competent to judge the usefulness of Lexica because I don't do translations. If I did, I'm sure I'd want this for its thesaurus capabilities; it's easy enough to use, and it sure looks a lot more useful than a straight translation dictionary.

Power Monitoring

We've had some heavy rains in Los Angeles recently, and while there's been nothing as bad as the Great Power Spike of 1989, we had trees across the power lines, dimouts, lights flickering, and the like. Since the time of the Great Power Spike, my systems have all been protected, by either the Clary OnGuard PC-2400 UPS

(uninterruptible power supply), which has served us so well, or Zero Surge units. Lately, we've been using another surge suppressor, the Lasermatch, from IEPS Electronics. I'm pleased to report that we have had no problems, except that the systems that had only surge suppression reset themselves when there was a power failure. The systems on the Clary UPS never noticed.

Unlike the surge suppressors you can buy in hardware stores, those from IEPS and Zero Surge do not use MOV (metal-oxide varistor) passive components. Instead, they use fairly massive coils and capacitors in an active circuit; the result is that they survive a power surge unharmed and ready to work again. That's not necessarily true of MOV systems, which can suffer progressive damage until they are useless—without your knowing it—leaving you with no protection when a bad surge happens.

Because of this, I have come to the conclusion that although the Zero Surge and IEPS units cost a great deal more than MOV systems, they are very much worth it, and I recommend that you replace your MOV suppressors with Zero Surge or IEPS products. Use the old MOV boxes as power strips, but don't rely on them for surge suppression.

Replace your MOV suppressors with Zero Surge or IEPS products.

One thing that has opened my eyes to power quality is the Eastern Time Designs Probe 100 power-line monitor. This is a small box that you plug into your power system. It watches for low power, momentary dropout, outages, power spikes, high-frequency noise on the line, and so forth. If such things happen, the unit lights the appropriate LED. During the rains, I found that we often had power surges of 50 volts above normal, as well as occasional neutral-line impulses and fairly frequent line "sag" events. Because of our active surge suppressors and the Clary UPS, none of this was a problem. But it could have been if we'd been using MOV suppressors only.

The Probe 100 is inexpensive enough that any computer consultant or MIS manager ought to have one. Find out just how reliable—or unreliable—your power is.

Eastern Time Designs also makes fancier power-monitoring equipment; if you're responsible for lots of laboratory electronic systems or a large computer network in an area with flaky electric power, it would pay to get one of their recording units. That way, if a power event crashes your system, you'll know precisely what happened.

Incidentally, we did have one problem during the rains. I'd recently taken our Mannesmann Tally laser printer off my system and put it on Roberta's. Alas, it wasn't plugged into any kind of power conditioner at all. In the middle of the Big Rain, a tree branch periodically shorted out the power lines, causing big arcs that generated alternating power dips and spikes. When it was all over, the printer

had lost its memory.

We can reprogram it, but it quickly forgets its emulation instructions. I've used that printer a long time, and I like it. Since the self-test shows that it prints all right, the problem is clearly in the interface electronics.

I don't expect fixing it will be terribly expensive, but it will certainly cost more than buying a Zero Surge or IEPS surge suppressor. The moral here ought to be obvious.

CD-ROMs

The bribe of the month is a World War II olive drab helmet liner. It fits, too, although when I wear it, Roberta can't stop laughing. I'm not sure what I'll do with it. It came as part of a promotional package for the Quanta Press CD-ROM of World War II. The CD-ROM has a whole bunch of photographs, all public domain, from the 1938 to 1945 era. There are pictures of the major leaders, military equipment, battle scenes, and suchlike, and a fair amount of well-indexed text. If you have to do a term paper on World War II, this is just the thing to have. Talk your school library into getting one.

TimeTable of History from The Software Toolworks combines standard timetables, stories, pictures, and sounds of history from the time before humanity to the present. Get this for fun, or for education, or just for the heck of it.

Stock Master

This moderately expensive program comes billed as a way to pick stocks for investments. The blurb says this software has "the ability to predict where stocks are headed.... You can search through thousands of stocks in a short time using the many indicators available, in any combination you desire. Turn them all on and see what golden stocks fall out."

The program also features "the incorporation of indicators used by professional traders that until now have been unavailable to the public. These include Elliot wave counts, Gann lines, Fibonacci calculations, Oscillator, Stocastics [sic], Japanese Candlesticks, and Cycles. Don't know how to use Candlesticks? No problem. The software will label the candlesticks with a bullish or bearish arrow."

OK. That's what the publisher says: Get this software and make a bundle.

Maybe. Me, I keep thinking that it can't be that easy to make money in the stock market. I keep remembering that most money managers, even with much bigger computers than I've got, historically have not done much better than I'd have done buying Dow-Jones futures. Some haven't done as well.

When I was a lad, there were many "technical analyst" theories on how to make money in the market. I read what it meant when rails and utilities went in different directions, and why you should watch "can" (the New York Stock Exchange listing for American Can, now Primerica Corp.). I also noticed that theorists made more from books about their systems than they did in the market.

If you've ever wondered what kind of tea leaves modern technical analysts use, this may be a good way to find out—but I wouldn't spend the profits just yet.

Finance 10

This package from Financial Software doesn't try to make you rich. It just tells you how to calculate a bunch of stuff relevant to finances.

Finance 10 has programs to find things like bond yield to maturity, depreciation, present value/future value, internal rate of return, and loan amortization schedules.

continued

It will generate a personal financial statement. Not the earth, but it does the job.

Corporate Voice

Originally called Readability for the PC, this remains one of the most useful style-analysis programs around. However, I'm not sure it ought to be used for the purposes it's advertised for, and it's easier to say what it's not than what it is.

It's not a spelling checker or a grammar checker. Since just about every decent word processor has a spelling checker, that's no problem. But if you need a grammatical analysis, this isn't a substitute for Grammatik. (Incidentally, there's a new version of Grammatik that's a real improvement over the previous version. I'll have a report on it soon.)

What Corporate Voice does is compare your text style to selected texts of different styles. It looks at word length, sentence length, ratio of common to uncommon words—it calls these items "mortar and bricks"—and other semantic variables. It also shows you patterns: Do you have long words in long sentences? Is your style monotonous, with short, choppy sentences? How does your text pattern compare with well-known essays, or scientific articles, or fiction? What is its readability index? Fog factor?

Other programs will compute some of these indexes, but Corporate Voice is easily the most useful of the lot, and its capability to compare your work to other texts is unique. The graphical presentations tell you more about your writing style than you'd have thought possible.

The program is advertised as a useful way to generate a company style or corporate voice. You can make your memos look like the boss's. This may or may not be a good idea. If your boss is a bad writer, it's a terrible idea.

Unfortunately, Corporate Voice hasn't been revised for a while, and it works only with older versions of the better-known word processors or with ASCII files. You may need Word for Word to translate back and forth. However, used properly, Corporate Voice can help your writing.

Street Atlas USA for Windows

This CD-ROM from DeLorme Mapping features maps showing just about every street in the country. I used to keep city maps of everywhere I've been, because I never know when a novel will need a scene set in another city; but this is up to date, takes up less room, and is easier to use. It's also surprisingly complete, with maps of towns I've never been to.

If you need it, you'll like it a lot. Recommended.

Last.Bat

A few months ago, I mentioned replacing computer batteries. Shortly after that, I heard from Accumation, reminding me that I should have used their Last.Bat, which never needs replacing. Last.Bat consists of a rechargeable battery and a connector to plug it into the computer's power supply. It's simple to install, and it works.

I installed a Last.Bat on a Zenith Z-248 some years ago. It worked fine, the only problem being that I forgot to remove it before passing that machine along. I suppose it's working still. I've put the new Last.Bat in my 486/33, since I expect to have that for years. Obviously, you can live without Last.Bat, but it makes one less thing to worry about. Recommended.

Comdex Spring/Windows World

It was quite crowded at Comdex/Windows World, with plenty of enthusiasm and

excitement. It wasn't that there was so much that was really new as that things long expected finally became real. IBM showed off OS/2 2.0. Quarterdeck was showing Desqview/X again, but this time they're shipping it. Windows 3.1 is real and out there, and so are a lot of Windows applications we've long awaited.

This was the third Comdex at which BYTE has given the Best of Show awards. It's hard work. Along with the other BYTE editors, Roberta and I have to run all over the show floor looking for the best new products; then the BYTE editors get together (in what is for me the best editorial meeting of the year) to argue about which products will have the biggest impact on users and the industry.

This year, the system and best-of-show awards went to Zenith's new Z-Note laptop series. Interestingly, Zenith won last year with their Mastersport 386SL laptop—and I'm writing this on one, having decided that of the crop of laptops I have at Chaos Manor, this is the one I prefer to carry. I turned on the Mastersport well before takeoff when I got in my seat at the Los Angeles airport, and I didn't turn it off until we landed in Chicago. The batteries held up just fine despite my having the screen brightness turned well up. The Z-Note series promises to be as good as the Mastersport I'm carrying, and it adds built-in network connections. It can even be upgraded to active-matrix color.

I've always been fond of Zenith laptops. For years, I carried the Supersport SX despite its weight because of its keyboard and bright screen. I can report that the Supersport is still working. It was stolen last fall and recovered by the San Diego police in a raid. All the identification had been removed from it, but when the police turned it on, up popped my name. I've just sent it on another torture test, and I expect it to do fine. Zenith makes rugged equipment.

I haven't had a chance to work with the other BYTE Best of Show products.

Alas, this year we didn't have a category for new technology, which is a pity, because I think the most exciting product at Spring Comdex was Cyrix's line of 486 chips. There's the 486SLC-25, which directly replaces the 386SX-25 to more than double the system's speed. Cyrix had one demonstration in which they had unsoldered the 386SX chip and replaced it with their own; it was the fastest "386SX" I've ever seen. They have a tiny 486 chip set for laptops and a chip that is pin compatible with the 386 but converts it to a 486. In a year or so, there won't be any reason not to have a fast computer system.

There was a lot more at Comdex. I saw the Video Machine, a board that does

ITEMS DISCUSSED

Autobook:
ADA 2.0 ....$89.95
Intermedia Design Systems, Inc.
950 New Loudon Rd., Suite 200
P.O. Box 10
Latham, NY 12110
(518) 783-1661
fax: (518) 783-1666
Circle 1146 on Inquiry Card.

CD-ROM of World War II..............$129
Quanta Press, Inc.
1313 Fifth St. SE, Suite 208C
Minneapolis, MN 55414
(612) 379-3956
fax: (612) 623-4570
Circle 1147 on Inquiry Card.

CompareRite $140
Jurisoft
955 Massachusetts Ave.
Cambridge, MA 02139
(800) 543-6862
(617) 864-6151
fax: (617) 661-0630
Circle 1148 on Inquiry Card.

Corporate Voice $249.95
Scandinavian PC Systems
P.O. Box 3156
Baton Rouge, LA 70821
(800) 487-7727
(504) 338-9602
fax: (504) 338-9670
Circle 1149 on Inquiry Card.

Courier HST Dual Standard $1295
USRobotics, Inc.
8100 North McCormick Blvd.
Skokie, IL 60076
(800) 342-5877
(708) 982-5010
fax: (708) 982-5235
Circle 1150 on Inquiry Card.

End Note Plus $249
Niles & Associates, Inc.
2000 Hearst St., Suite 200
Berkeley, CA 94709
(510) 649-8176
fax: (510) 649-8179
Circle 1151 on Inquiry Card.

Finance 10 ....$69.95
Financial Software Co.
P.O. Box 481290
Los Angeles, CA 90048
(800) 332-2983
(213) 658-7731
fax: (213) 658-7868
Circle 1152 on Inquiry Card.

486SLC-25
(OEM pricing only: $119 each in quantities of 1000)
Cyrix Corp.
2703 North Central Expy.
Richardson, TX 75080
(214) 234-8387
fax: (214) 699-9857
Circle 1153 on Inquiry Card.

Graphic Workshop 6.1 ....$40
Alchemy Mindworks, Inc.
P.O. Box 500
Beeton, Ontario,
Canada L0G 1A0
Circle 1154 on Inquiry Card.

Lasermatch...................$99
IEPS Electronics
11391 Meadowglen Dr.
Houston, TX 77082
(713) 558-0010
fax: (713) 558-9738
Circle 1155 on Inquiry Card.

Last.Bat....................$49.95
Accumation, Inc.
8817 Southwest 129th Ter.
Miami, FL 33176
(305) 238-1034
fax: (305) 252-3674
Circle 1156 on Inquiry Card.

Lexica $295
WordStar for Windows $495
WordStar International, Inc.
201 Alameda del Prado
P.O. Box 6113
Novato, CA 94949
(800) 227-5609
(415) 382-8000
Circle 1157 on Inquiry Card.

Lotus Write for Windows 2.0 ....$199
Lotus Development Corp.
Word Processing Division
1000 Abernathy Rd.
Building 400, Suite 1700
Atlanta, GA 30328
(800) 831-9679
(404) 391-0011
fax: (404) 698-7653
Circle 1158 on Inquiry Card.

continued

broadcast-quality video editing on a PC; a whole raft of multimedia hardware and software, including new sound and video products from Media Labs and Creative Labs; a wonderful new monitor from ViewSonic, as well as new monitors from NEC; a ton of video cards; and, as they say, much more, some of which I'll be talking about in the next few months.

One other thing: BYTE and IntelliQuest presented a breakfast seminar about marketing strategy and the future of the computer industry. I went expecting to be bored; but even though I hate breakfast meetings, I was fascinated. Nobody told me to recommend this, but if you want to find out how new technology gets adopted, you can get this briefing at IntelliQuest seminars, or much of the information is available through the BYTE salespeople.

Every year I leave Comdex exhausted, but I'm glad I go.

Winding Down

The computer book of the month is Larry Pina's *The Dead Mac Scrolls* (Peachpit Press, 1992). It's all about simple but secret ways to fix puzzling Mac problems; trust me, if you have a Mac, you definitely need this book.

The not-quite-computer book of the month is *Civilization* by Johnny L. Wilson and Alan Emrich (Prima Publishing, P.O. Box 1260CIV, Rocklin, CA 95677, (916) 786-0449). If you're serious about playing Civilization, this is the book you need. The book of the month is Graham Fuller's *The Democracy Trap* (Dutton, 1991), an analysis of political/social problems we face as the cold war ends. I'm currently writing on the same subject. This is well worth reading.

The shareware of the month is Graphic Workshop 6.1, which is available on BIX and GEnie. This is a truly useful program for converting graphics image formats as well as for generally messing about with PC graphics.

By next month, I may have a report on OS/2, and I'll certainly have a number of new Windows products. The PC world just keeps changing all the time. Isn't that wonderful? ■

Jerry Pournelle holds a doctorate in psychology and is a science fiction writer who also earns a comfortable living writing about computers present and future. Jerry welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply. You can also contact him on BIX as "jerryp."

ITEMS DISCUSSED

Microsoft Windows 3.1 ....$149.95
Microsoft Word for Windows 2.0 ....$495
MS-DOS 5.0 ....$99.95
Microsoft Corp.
1 Microsoft Way
Redmond, WA 98052
(800) 426-9400
(206) 882-8080
fax: (206) 883-8101
Circle 1159 on Inquiry Card.

Norton Desktop for Windows 2.0 ....$149
Symantec Corp.
10201 Torre Ave.
Cupertino, CA 95014
(800) 441-7234
(408) 253-9600
fax: (408) 252-4694
Circle 1160 on Inquiry Card.

OnGuard PC-2400....$1590
Clary Corp.
320 West Clary Ave.
San Gabriel, CA 91776
(818) 287-6111
fax: (818) 286-7216
Circle 1161 on Inquiry Card.

Probe 100 ....$149.95
Eastern Time Designs, Inc.
2626 Brown Ave.
Manchester, NH 03103
(800) 872-4383
(603) 645-6578
fax: (603) 623-8930
Circle 1162 on Inquiry Card.

QuickPay 2.0............$59.95
Intuit, Inc.
P.O. Box 3014
Menlo Park, CA 94026
(800) 624-8742
(415) 322-0573
fax: (415) 322-1013
Circle 1163 on Inquiry Card.

Stock Master...............$149
Trading Techniques, Inc.
677 West Turkeyfoot Lake Rd.
Akron, OH 44319
(216) 645-0077
fax: (216) 645-1230
Circle 1164 on Inquiry Card.

Street Atlas USA for Windows CD-ROM....$169
DeLorme Mapping
Lower Main St.
P.O. Box 298
Freeport, ME 04032
(207) 865-1234
fax: (207) 865-9628
Circle 1165 on Inquiry Card.

Supra Fax Modem $169.95
Supra Fax Modem V.32bis......$399.95
Supra Corp.
7101 Supra Dr. SW
Albany, OR 97321
(800) 727-8772
(503) 967-2440
fax: (503) 967-2401
Circle 1166 on Inquiry Card.

TimeTable of History CD-ROM.................$99.95
The Software Toolworks
60 Leveroni Court
Novato, CA 94949
(415) 883-3000
fax: (415) 883-3303
Circle 1167 on Inquiry Card.

Video Machine
(available in September for about $4000)
Fast Electronic U.S., Inc.
5 Commonwealth Rd.
Natick, MA 01760
(508) 655-3278
fax: (508) 650-0447
Circle 1168 on Inquiry Card.

Word for Word Professional.................$149
Mastersoft, Inc.
6991 East Camelback Rd., Suite A320
Scottsdale, AZ 85251
(800) 624-6107
(602) 277-0900
fax: (602) 970-0706
Circle 1169 on Inquiry Card.

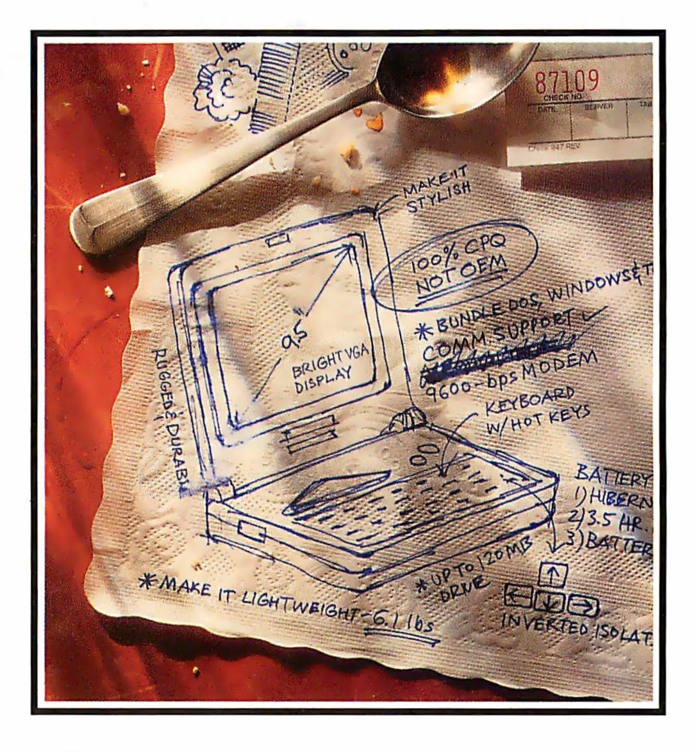
Z-Note 320L Model 60....................$3599
Z-Note 325Lc Model 120..................$7299
Zenith Data Systems
2150 East Lake Cook Rd.
Buffalo Grove, IL 60089
(800) 553-0331
(708) 808-5000
Circle 1170 on Inquiry Card.

ZS900...........................$149
ZS1800.........................$199
Zero Surge, Inc.
103 Claremont Rd.
Bernardsville, NJ 07924
(908) 766-4220
fax: (908) 766-4144
Circle 1171 on Inquiry Card.

People In The Computer Business Have Been Trying To Improve On Compaq For Years.

Guess Who Fi

It wasn't easy. Changing a company our size never is. But we listened to our customers, we studied our competitors, we took a long look in the corporate mirror. Then we did the only thing we know how to do. We rolled up our sleeves and went to work.



The result of all this work will begin to appear in the weeks to come. You'll see new prices, new customer support, new ways of distribution and, naturally, new products.

Everything from inexpensive machines for basic computing needs, to advanced products that stretch the envelope of technology at prices that our customers will find compelling and our competition should find, well, competitive.

What you won't see are stamped-out, second-rate products with the COMPAQ name stuck on at the end of somebody else's assembly line.

While that may be the way of the world, it's not the COMPAQ way.

We've always believed that the performance, compatibility, reliability, and actual affordability of a computer has more to do with innovation than with imitation.

So instead of asking

NALLY DID IT?

1200 of the world's finest computer engineers to forget all they knew about building great computers, we asked them to take all they knew and build great inexpensive computers.

Engineering to cost vs. engineering at any cost.

And as the best engineers do, they saw this not as a limitation, but as a challenge. A hurdle to overcome. A problem to ponder, twist, push, pull and ultimately solve.

They questioned manufacturing techniques, they challenged our suppliers, they turned every aspect of every process upside down, inside out and sideways until they had managed to shake out every unnecessary cost or component.

No more over-think.

No technology simply for the sake of new technology.

And along the way to our new and improved destination, we learned a little something.

We learned that what makes a COMPAQ PC more than just another computer isn't simply the engineering. Or design. Or component quality. Or product testing.

It's not just the more tangible things such as compatibility or near-zero defect production or the dozens of other examples you'll be discovering for yourself on the following nine pages of this advertisement.

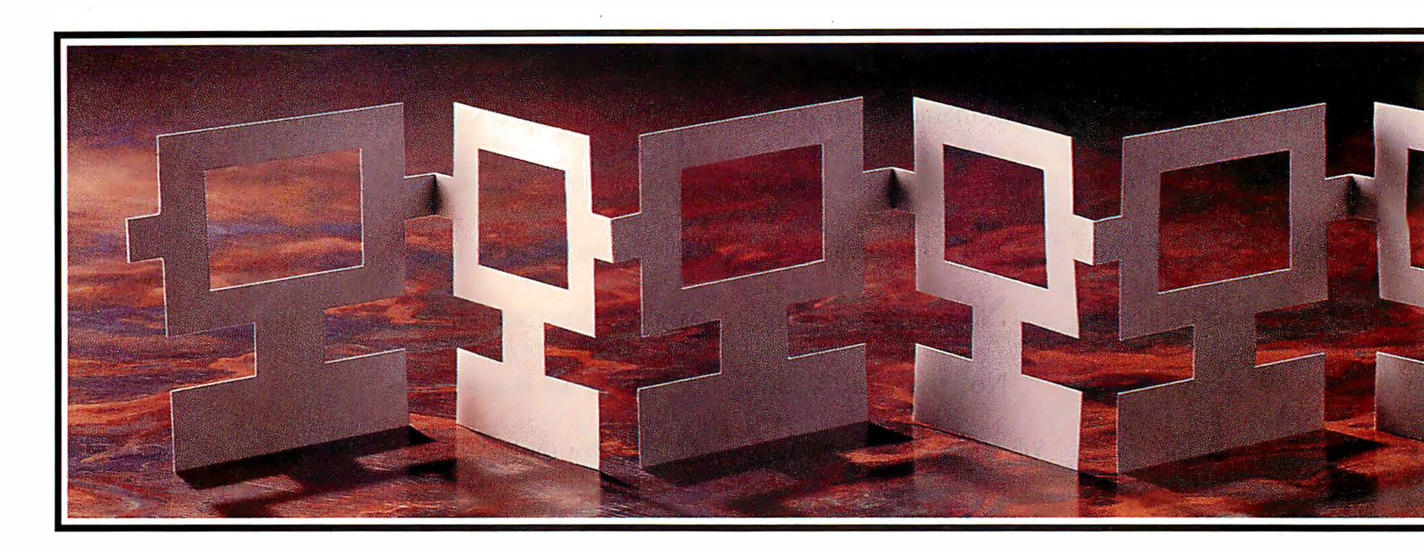
When all is said and done, what truly makes a COMPAQ PC far more than simply another computer is simply passion.

The passion to push technology, the passion to recognize the idea whose time has come, the passion to listen and learn and adapt to whatever our customers may want today while anticipating what they might need tomorrow.

In other words, the passion to do things right for the customer.



AT MOST COMPUTE
STANDS FOR REPLIC



It's hard to believe, but at some PC companies the engineering department is nowhere to be found. Which stands to reason, since most other computers aren't engineered, they're copied. And, as with all copies, something is frequently lost in the translation.

What happens when companies lack the engineering depth to make new things happen? You guessed it...new things don't happen.

A fact few understand better than the 1200-plus engineers at Compaq.

The same engineers who developed the first portable computer with dual-mode monitor and an industry standard for compatibility. And the world's first desktop PC with concurrent bus.

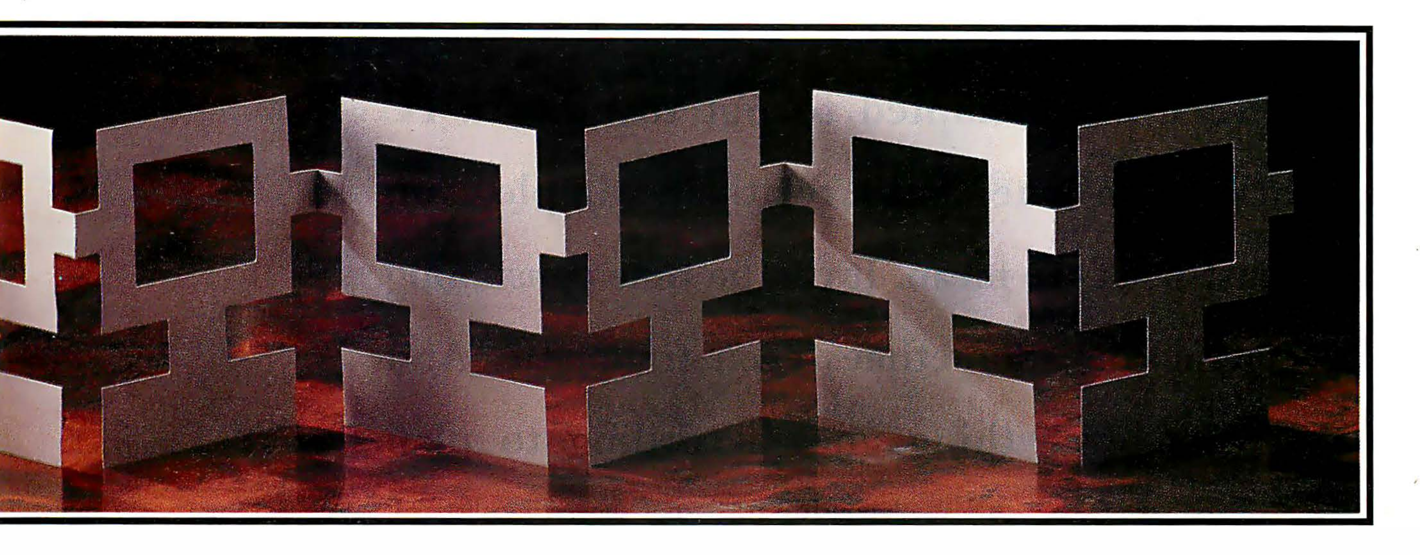
The same engineers who designed and delivered the first 386 PC. And managed to break the 32-MB barrier in hard-drive technology.

Just for starters.

So what have we been up to lately?

Among other things,

R COMPANIES, R&D
ATE AND DUPLICATE.



we just introduced the world's first lightweight 386SL/25 notebook PC with 120-MB hard drive and full desktop expansion capability.

Our engineers have developed sophisticated Windows accelerators, and conducted extensive research and testing to optimize Windows 3.1 performance on every COMPAQ computer. A test other companies will no doubt leave you to perform on your own.

We've even been designing enhanced fault-tolerance features into our drive array adapters to make data reconstruction and retrieval easier, more automatic and far less disruptive to everyday operation.

As you read this, we're working on dozens of new computing ideas.

Some will arrive next week. Some next year.

Some may change the way you look at computers forever. Others will simply make next year's COMPAQ products work a little better.

And finally, some will be just the kind of ideas our competitors have been looking for.

Ideas that wouldn't occur to them, however, until they looked inside a COMPAQ PC.



VARIETY MAY BE
BUT TO A COMPUTER
THE KISS

If you've ever attempted to put together a PC network, even one that's relatively simple, you know just what we mean. It can be time consuming. Nerve wracking. Sometimes even traumatic. And that's when everything goes according to plan.

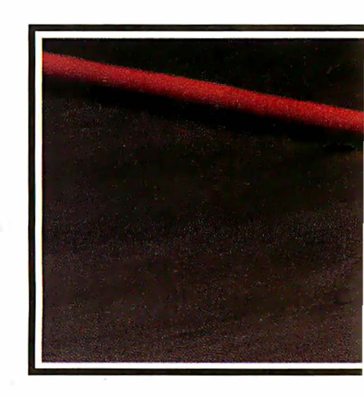
Now obviously, variety is a fact of life when dealing with networks. There's probably not a single LAN that doesn't include a few PCs from one manufacturer, some more from another, and still more from a third. (Not to mention a vast assortment of peripherals, interface cards and operating systems.)

And, being a leading proponent of PC technology, we're certainly not suggesting that you scrap all your hardware and start from scratch with strictly COMPAQ products.

We do recommend, however, that as your needs expand, you think a little differently about how you approach your next PC purchase.

Because, as you may have noticed, when you put bargain-basement variety components together and subject them to the increasingly complex demands of today's computer network environments, compatibility problems arise.

It's like being at a bad cocktail party. Nobody talking to anybody and



everybody blaming the one who brought them all together.

And suddenly you find your well-thought-out, master-minded PC network has turned into a house of cards hit by a

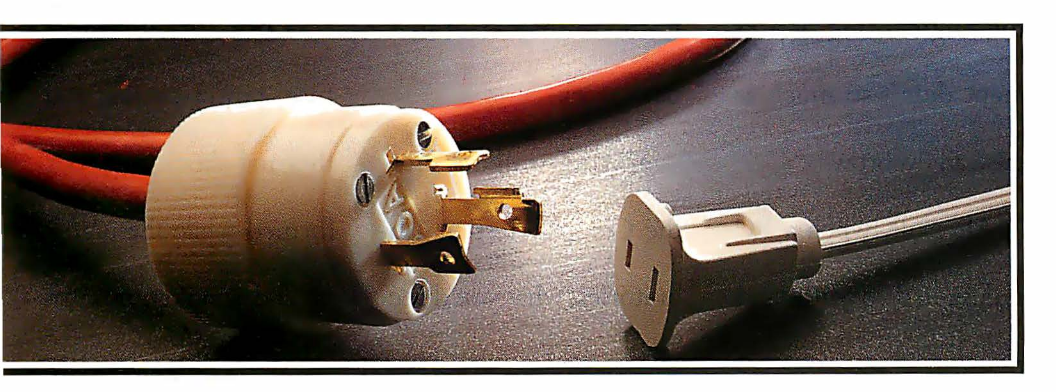
The Spice Of Life, Network, It Could Be Of Death.

rather stiff breeze.

On the other hand, there's Compaq.

Unlike other computer companies, we have an entire group of engineers who are dedicated exclusively to testing network environments. Working with the world's major software companies like Novell, Banyan, SCO, Microsoft, and others, they test all COMPAQ products in very active, multi-user environments network installations.

As a result, you can be assured you're getting products designed, engineered and thoroughly tested to operate within the most complicated network environments.



and communication hardware and software.

In addition, we have teams of engineers who continually monitor the everyday performance of all COMPAQ computers within various network for hours, days and even months on end.

To make integration easier, we offer COMPAQ TechNotes and ToolKits, the most sought-after guides in the computer industry for multi-vendor

In short, products built by a company dedicated to solving potential PC network integration problems in our offices.

That way you don't end up having to solve them in yours.



WHAT YOU DO WITH A CO
THE FACT THAT YOU MIGH

Not too long ago, Denise Anderson of Morrison, Colorado, left her COMPAQ notebook PC in, of all places, her driveway. When next seen, the 6.9-pound computer had become a speed bump for 1.3 tons of automobile. When next used, it started up just fine.

Now, that may have been a bit surprising to Denise, but at Compaq, the engineering department didn't so much as raise an eyebrow.

After all, when a PC is designed to withstand the slings and arrows of today's business world, a small thing like a minor traffic mishap is all in a day's work.

If you walked into the Compaq testing laboratories, what you'd see is a computer owner's worst nightmare.

Computers subjected to the kinds of conditions you would only encounter during the height of summer in the Sahara. Or midnight in an Arctic winter.

Humidity, temperature, power-cycling and thermal-shock tests performed while the unit is up and running, not just



MPUTER IS YOUR BUSINESS.
T ACTUALLY DO IT IS OURS.

for a few hours, but for days and weeks to simulate years of normal use.

Keyboards that are pounded and punched millions of times, often with dust, dirt, ashes and other kinds of contaminants dumped into their workings.

Portable computers being opened and closed up to 20,000 times to ensure the integrity of the hinges. And dropped over and over again from terrifying heights, right onto their most vulnerable corners.

Just to make sure that your notebook PC can survive a couple of unattended hours stuck in the trunk of your car. Or the power surges of your electrical system. Or even an occasional heavy-handed operator.

But the important part of the story isn't simply that we put our products through one of the most rigorous testing programs in the entire computer industry.

The important part is they survive it.

That means reliability and serviceability are designed into the products, not added on as an afterthought.

It means thermal simulations to determine the best locations for components and cooling devices. And electrostatic discharge protection integrated into the system from the start.

It means consistency of component quality from one production run to the next. And to the one after that.

It means, quite simply, that the ultimate goal of every Compaq engineer is to design a product that works, and keeps on working, no matter what.

A product, in other words, that won't break down under the pressures of today's complex business world.

Even when the pressures come to 1.3 tons.



FOR SERVICE AND SUPPO
ARE NOT STANDING

With our new service and support program, what you need is what you get. In fact, our technical support staff resolves 95% of all calls in under 15 minutes. And for questions that require greater expertise, we have engineers ready to get on the line.



All of which is just part of CompaqCare, a comprehensive new program designed to provide you with everything you may need when it comes to service and support. Quickly and easily.

Our free on-site* one-year, limited warranty, for instance, will cover practically anything that could happen to any of your COMPAQ hardware, anywhere it occurs in the U.S.A. or Canada. And, unlike most of our competitors' programs, the new Compaq on-site warranty covers every product we build.

And no matter where you take COMPAQ portable or notebook PCs, they're also backed by a worldwide, one-year, carry-in warranty.

So wherever business takes you—from Tokyo to Turkey, Britain to Berlin—you can feel perfectly comfortable taking your COMPAQ portable along with you.

We also give users the flexibility to choose from over 2,000 Authorized COMPAQ Reseller service locations.

Or you can call on us directly for service.

For companies with technicians already on board, we offer a self-maintainer program that gives you access to all the support resources you need to perform whatever service you may find necessary.

And, of course, while

RT, JUST CALL. OPERATORS
BY. ENGINEERS ARE.



increasing the scope of our warranty programs has certainly been our priority, we've also been working on many other important aspects of customer support.

Whenever you have questions, for example, the Compaq SMART System provides all our support personnel with a sophisticated information bank comprised of thousands of hours of troubleshooting and engineering expertise. Which means the person who answers your call is certain to supply you with consistent, smart answers to all of your questions. And take care of even your most pressing problem. We even have on-line access with most of the major software companies to help you quickly take care of those software-related difficulties that you may encounter.

You'll also gain 24-hour electronic support through three different services: CompuServe, PAQFax, and QuickFind, our CD-ROM technical reference library.

If, after all of the above, you're still not quite convinced that our new service and support program is one of the most comprehensive in the industry, call us on it.

1-800-345-1518.

On the other end of the phone, you'll find a whole bunch of people looking for trouble.



A Thought For Those Who Appreciate The Value Of A Dollar As Well As The Value Of A Compaq.

"Now that we've made clear all the things that Compaq stands for, let us make it clear what we won't stand for anymore. High prices. We have a new mission. A new goal.

To provide you with Compaq quality, Compaq research and development, Compaq reliability and testing and service and support at the most competitive prices possible.

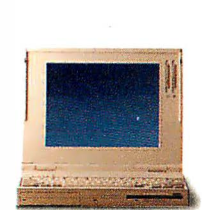
In other words, products that are exactly what you need, easy to find, and priced right.

That's what Compaq is all about today.

For the details on all of the above, yes even the prices, give us a call at 1-800-345-1518, Ext. 205, in the U.S., 1-800-263-5868, Ext. 205, in Canada.

We think you'll like what we have to say."

—Eckhard Pfeiffer
President, CEO
Compaq Computer Corporation

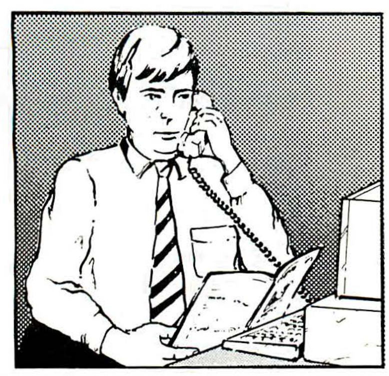







Buy with

Confidence



In an effort to make your telephone purchasing a more successful and pleasurable activity, The Microcomputer Marketing Council of the Direct Marketing Association, Inc. offers this advice, "A knowledgeable buyer will be a successful buyer." These are specific facts you should know about the prospective seller before placing an order:

Ask These Important Questions

- *How long has the company been in business?*
- *Does the company offer technical assistance?*
- *Is there a service facility?*
- *Are manufacturer's warranties handled through the company?*
- *Does the seller have formal return and refund policies?*
- *Is there an additional charge for use of credit cards?*
- *Are credit card charges held until time of shipment?*
- *What are shipping costs for items ordered?*

Reputable computer dealers will answer all these questions to your satisfaction. Don't settle for less when buying your computer hardware, software, peripherals and supplies.

Purchasing Guidelines

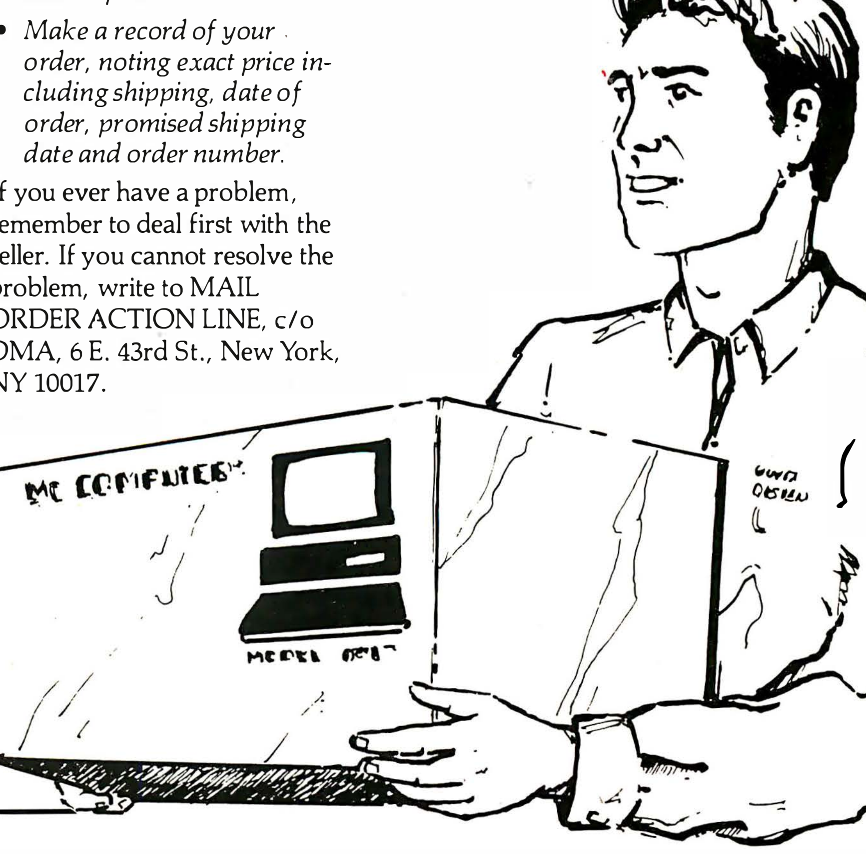
- *State as completely and accurately as you can what merchandise you want including brand name, model number, catalog number.*
- *Establish that the item is in stock and confirm shipping date.*
- *Confirm that the price is as advertised.*
- *Obtain an order number and identification of the sales representative.*
- *Make a record of your order, noting exact price including shipping, date of order, promised shipping date and order number.*

If you ever have a problem, remember to deal first with the seller. If you cannot resolve the problem, write to MAIL ORDER ACTION LINE, c/o DMA, 6 E. 43rd St., New York, NY 10017.

This message is brought to you by:

the MICROCOMPUTER MARKETING COUNCIL of the Direct Marketing Association, Inc.
6 E. 43rd St.,
New York, NY 10017





COVER STORY

FEATURE

The PC Gets More Personal

Smaller, smarter systems from Apple, Dell, and Gateway 2000 usher in a new era of portable computing

OWEN LINDERHOLM, STEVE APIKI, AND MICHAEL NADEAU

Portable computers are about to get a lot smaller. In the process, they will gain new features while sacrificing little, if any, power. Small computers will begin to take new forms as well, to fill a demand that conventional portables cannot. This change is the beginning of a new generation of computers that will cater to the diverse needs of both veteran and novice users.

The driving force behind these new portables is the industry's need to expand the computer market. Key breakthroughs in technology are feeding the process. Storage devices are getting smaller. IC designs sport fewer chips, system boards have shrunk, and power requirements are lower.

BYTE ACTION SUMMARY

Apple is pioneering a new type of computer called a Personal Digital Assistant, a device that you can easily carry anywhere and that adapts to your style of working. Other vendors, such as Dell and Gateway 2000, are trying to achieve the same goal by making conventional PC designs more portable and powerful. The ultimate goal for both camps is to broaden the user base for personal computers. Apple may have the best chance.

Two distinctly different portable computer designs have emerged: a new breed of full-featured subnotebooks and advanced PDAs (Personal Digital Assistants). Dell Computer and Gateway 2000 have introduced two charming notebook PCs. Both provide good performance, sacrificing few amenities, in packages weighing no more than 3½ pounds. Feature for feature, these units stack up well next to their 6-pound notebook cousins.

Hot on the heels of the Dell and Gateway products are subnotebooks based on Phoenix Technologies' Companion PC reference design. BYTE has not seen a working model of the Companion PC, but plans call for it to weigh less than 3 pounds and feature a PC/Chip CPU, a PCMCIA card slot, and, most important, embedded software built around a common shell, making the unit ready to go and easy to use right out of the box.

Apple's pen-based Newton, on the other hand, is a clean break with the past. It resembles a computer only in that it uses a CPU and has an LCD. The Newton's closest relatives are hand-held systems such as



ILLUSTRATION: MARK ROCKWOOD. PHOTOGRAPHY / JOHN KRAMER, IMAGESET DESIGN, INC. © 1992
PROTOTYPE PHOTOGRAPHY: APPLE COMPUTER, INC.


reads my writing
Compatible w/ Mac and PC

Sharp Electronics' Sharp Wizard and Hewlett-Packard's HP 95LX. HP plans a pen-based version of this popular portable, says Kermit Yensen, product manager for the HP 95LX. However, the Newton is much more powerful than present-day hand-helds.

Apple's Radical Departure

The Newton is a pen-input device that combines a fast, new CPU with a multitasking operating system in a sleek package that weighs less than a pound. At about 7½ by 3½ inches, it can fit into a jacket pocket (see photo 1). A lid folds back to uncover the 6- by 3-inch screen, which doubles as the digitizing surface.

For storage, the Newton uses a single PCMCIA 2.0 card. Its slot is actually a superset of PCMCIA called TRIMbus—a full 32-bit, intelligent, multimaster bus that can accept PCMCIA memory and peripheral cards, as well as multiple, more complex devices. Apple expects that most add-on applications and peripheral cards will include additional memory. The Newton also has a small speaker for digitized sound output, and Apple is considering adding a microphone and voice-recognition capabilities to future models. The Newton uses flash EPROM. Low-end models will have 1 to 2 MB of memory; high-end models will climb to 20 MB.

The Newton's designers chose the ARM (Advanced RISC Machine) 610 processor (see the text box "Apple ARMs Itself" on page 134). Apple says this CPU gives the Newton up to two times the computing performance of a Mac IIfx, and the ARM processor requires only about half a watt of power. At press time, Apple was still evaluating what type of battery the Newton would run on and refused to estimate battery life, although sophisticated power management software is part of the operating system.

Apple gave the Newton a lot of horsepower so that it will be easy to use. Conventional low-power CPUs can't drive the applications and interface that make the Newton unique. The Newton's advanced handwriting-recognition software and its Intelligent Assistant software, which anticipates a user's intentions, are available at all times.

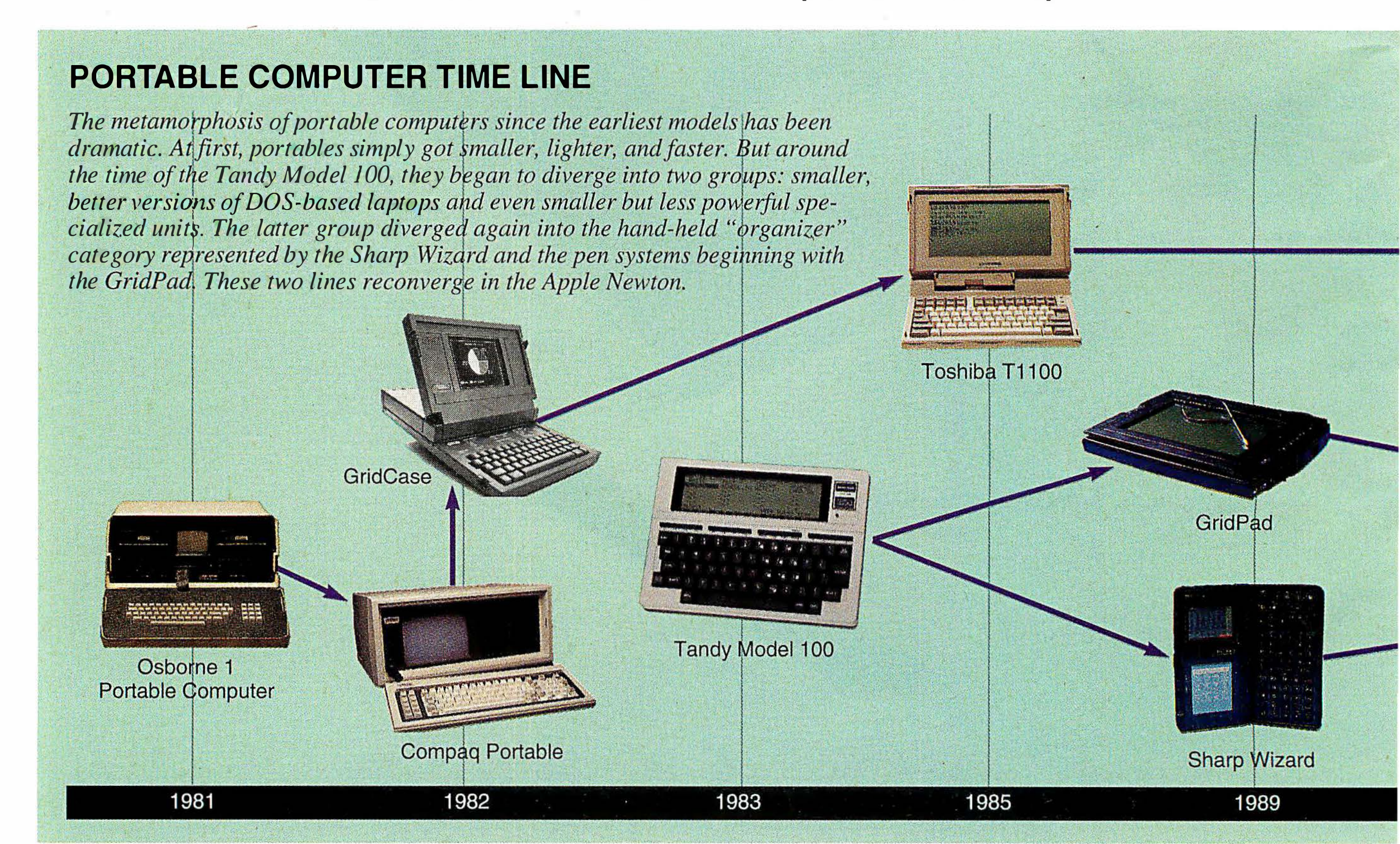
NewtOS and the Intelligent Assistant

NewtOS is the Newton's new, nonderivative, fully preemptive multitasking operating system. It is designed to work effectively in limited memory and uses an object-based data and view architecture. Applications use a forms engine called Forms Runner to overlay windows onto underlying object data. These forms can be easily created and edited with simple pen controls. Apple says it developed its own operating system because nothing else available would work with the limited resources in the Newton or was able to take advantage of the ARM CPU.

As a result of the preemptive multitasking of NewtOS, the Newton can use multiple handwriting recognizers simultaneously. Apple is planning to supply a printed-text recognizer, a graphics recognizer, and a pen-command recognizer that work together. They can arbitrate among themselves to make sure that the appropriate recognizer makes the best possible choice. In addition, Apple is working with Paragraph International in Boulder, Colorado, on cursive-handwriting recognition.

From the brief demo BYTE saw, the printed-text recognizer in the Newton is very capable. It can automatically detect that words written in a line go together and that several written lines make a paragraph. It doesn't need special input tools like boxes, combs, grids, and underlines. It also knows about the size and spatial relationship of letters and numbers so that it can correctly recognize complex algebraic equations or differentiate large and small text and display it in different font sizes. It can even recognize text written at an angle.

The handwriting recognizer is better than most others that are currently available and is at least on a par with the new recognizer in Go Corp.'s PenPoint. Also unique to the Newton is that its



recognizer runs under a multitasking operating system. Several recognizers run in parallel, recognizing characters and words as you write. It performs a recognition not necessarily in written order but, rather, as soon as it is confident that it has a good match. For example, if you write *delicious drink*, it might recognize the word *drink* before it finishes deciphering *delicious*.

Even more impressive is the graphics recognizer. This is linked to an underlying object view of graphical information. For example, if you sketch a circle, it is immediately recognized and transformed into a perfect circle. If you erase a section of the circle, precisely that arc is removed from the object. If you then draw two lines away from the ends of the arc, the recognizer snaps them to the endpoints, makes sure they are parallel, and merges them to produce a graphical object, such as a thermometer bulb. The graphical recognizer automatically recognizes symmetry and parallel lines. It will be especially useful in applications such as architectural sketching, CAD, project planning, forming tables, and general sketching.

The Newton's screen is a virtual infinitely scrollable notepad. You simply start writing and sketching, and the Newton creates a document with a time and date stamp. Apple has managed to limit the number of pen commands to six, which underscores its commitment to keep it simple. For example, to start a new document, you draw a horizontal line across the page. At the bottom of the screen are controls for rapid scrolling and for access to the Intelligent Assistant, filing, the address book, the calendar, formatting, and other applications.

The most impressive software technology on the Newton is the Intelligent Assistant. It can interpret complex commands to the Newton and, as a result, perform a multitude of combined operations. The Intelligent Assistant uses a table of common words and phrases and matches recognized text against these to build up its command interpretations.

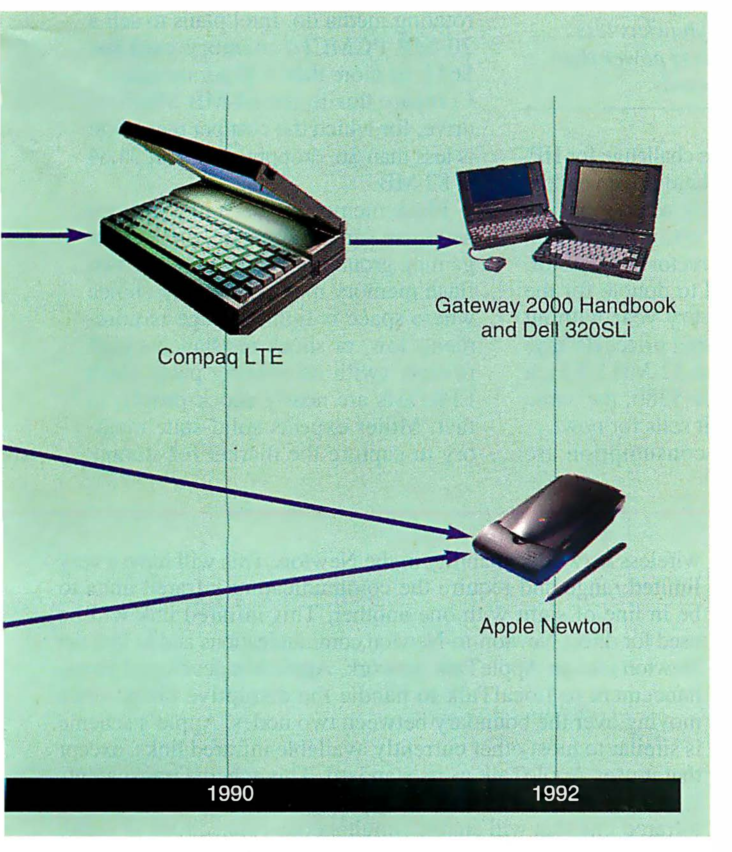




Photo 1: *The Newton is the first in a series of what Apple refers to as PDAs. This pen-input hand-held system combines a fast RISC processor with an innovative new operating system and software. Apple expects to sell the Newton for less than $1000 when the system becomes commercially available in January 1993.*

One Step Ahead

Apple's goal with the Intelligent Assistant is to make software that anticipates a user's intentions. For example, if you jot down notes during a meeting and they include the phrase *call Michael*, you can select the phrase with the pen and tap on the Intelligent Assistant icon. The program recognizes that you want to call someone named Michael and pops up your address book with all the Michaels selected. It also shows only their phone-number field. You pick the correct Michael, and it dials his number by issuing the appropriate tones through the built-in speaker.

Dialing a number is almost too simple for the Intelligent Assistant. You can highlight the phrase *fax a letter to Susan Jones* along with the main text of a letter. The Intelligent Assistant finds the name Susan Jones in your address book, builds a letter using your letterhead and appropriate salutations and formatting, and automatically faxes the letter. If a fax modem is not connected, it puts the fax in an out box for deferred transmission.

Since the Newton is an Apple product, it includes a Trashcan. When you select a document and drag it to the Trashcan, the on-screen document crumples itself up and lobs itself into the can, accompanied by appropriate sound effects.

Tim Bajarin, vice president of Creative Strategies International, a Santa Clara, California, market research firm, says the Intelligent Assistant is Newton's "greatest feature." He adds, "Apple should also get high praise for the audio feedback. When you use the Rolodex, you can hear the corners of the paper turn."

The Newton shows off in other ways, too. If you hold the pen tip down, it turns into a highlighter. Dragging the highlighter down the left side of a series of lines of text selects them all. The context-sensitive help system is somewhat like the Balloon Help in System 7.0 for the Macintosh.

The Importance of Communications

Communications is critically important for the Newton. Larry Tesler, head of Apple's Personal Electronics Division, says that

Enabling Technologies

MICHAEL NADEAU AND ED PERRATORE

For years, everyone from science fiction writers to industry notables has told us what the ultimate personal computer should be. We simply have not had the technology to build one. But breakthroughs in many areas will soon enable computer manufacturers to build smaller, more functional versions of existing models, as well as completely new designs. Two areas are of critical importance: mass storage and wireless communications.

The recently announced 1.3-inch Kittyhawk hard drive from Hewlett-Packard (see photo A) is a prime example of enabling technology. The drive measures only 2 by 1⅗ inches and is less than ⅖ inch high. The hard drive comes in either 14- or 21.4-MB capacities.

The Kittyhawk has other features that make it an ideal storage device for very small computers. The 5-volt drive requires only 1.5 watts for a read and 1.7 W for a write—important numbers for battery operation. And it's tough. According to HP, it can withstand an operating shock of 100 g's—the equivalent of dropping it 3 feet onto a concrete surface.

HP claims that a wide range of products will use this drive: cellular phones, laser printers, copiers, instrumentation, and video games. However, subnotebooks, hand-helds, and pen systems are the likely early users of the Kittyhawk.

Prior to the Kittyhawk, 1.8-inch hard drives have been available in Type 3 PCMCIA-card format. MiniStor Peripherals, for example, sells a 64-MB unit primarily for small notebook PCs and pen systems. The challenge for HP, MiniStor, and other hard drive vendors is to increase capacity while reducing size and power consumption. Jim Miller, marketing director at MiniStor, says capacities tend to double for the same size media every year without significantly increasing price. He says MiniStor will offer an 82-MB 1.8-inch drive next spring for $380, the same price the 64-MB unit sells for now.

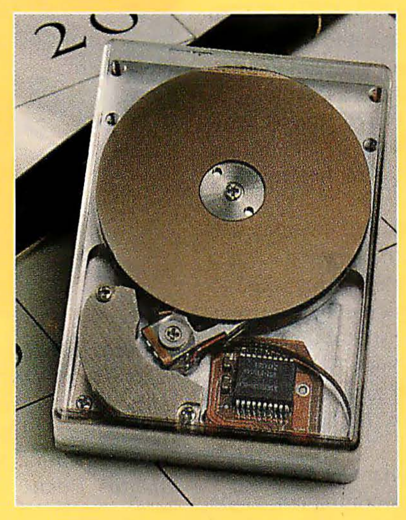


Photo A: *Hewlett-Packard's new Kittyhawk 1.3-inch hard drive will give manufacturers of hand-held computing devices more flexibility in design. Available in capacities of up to 21.4 MB, the Kittyhawk is less expensive and uses less power than solid-state memory cards.*

Size and power consumption are closely related. Media size is only one factor in reducing the mass of an entire hard drive. The interface, with its connector and associated circuitry, represents much of the bulk, and the more components to the interface, the more power it consumes. HP worked with AT&T Microelectronics to bring the chip count on the interface down to seven. The PCMCIA connector has already proved its ability to minimize the size of the connector.

Flash EPROM memory, or solid-state memory, is touted as an ideal storage medium for small systems, but it has three drawbacks: low capacity, relatively high power consumption, and high price—even with Intel's recent and dramatic price reductions. For a single PCMCIA flash EPROM card, 20 MB is the highest capacity available. Also, 5-V flash EPROM cards are only now becoming available, and they still require more power on a write than rotating media do. Intel plans to sell a 20-MB PCMCIA memory card for $611, or more than $30 per megabyte. Compare this to the 64-MB MiniStor drive, for which the cost per megabyte is less than $6, dropping to about $4.64 at 82 MB.

Flash memory is dropping in price and increasing in capacity, but it is not gaining ground on rotating media. Yet, flash memory may be the only choice where space is tight, storage requirements low, or shock resistance a high priority (with no moving parts, flash EPROMs are nearly shock-proof). In fact, Miller expects solid-state memory to capture the market for storage

Apple's goal is to let people "be in digital contact anywhere." To achieve this goal, Apple needs to implement wireless networking and eventually create or hook into a global wireless communications system. (See the text box "Enabling Technologies" above.)

In practice, for a global network to operate, it has to make use of a global communications infrastructure, such as the public phone system (cellular) or packet radio links. A global wireless network would let you use your PDA to link into a wide array of services: E-mail, on-line services (e.g., BIX or CompuServe), electronic news sources, and electronic paging.

As a first step, Apple is including a point-to-point infrared wireless network capability in the Newton. This will have a very limited range and require the communicating infrared units to be in line of sight with one another. This infrared link will be used for direct Newton-to-Newton communications and to link the Newton into an AppleTalk network. Apple has developed an enhancement to LocalTalk to handle the disruptive break when moving over the boundary between two nodes. Apple's scheme is similar to most other currently available infrared links, except that it uses AppleTalk as its standard. This scheme transparently deals with dynamic node assignment. Apple also plans a future infrared link that will enable simultaneous connections to multi-

devices under 20 MB.

Solid-state memory has another advantage: flexibility in design. The Companion PC reference design calls for no rotating media. Instead, it will use low-capacity memory cards. Since the Companion PC is targeted at a consumer market, price is a priority. By eliminating a large-capacity storage device, it can sell for around $600. The PCMCIA slot provides a means to add functions or memory at a later date.

The Wireless Connection

Wireless communications is the glue that bonds everything together. We've all heard a variation of the following scenario: As you go about your workday, your mobile computer polls the airwaves for many preselected types of messages. Maybe you want to have updates on stock quotes, instant notification of incoming MCI mail, or faxes sent to you wherever you happen to be. When your correspondence arrives, your digital buddy signals you. You can respond immediately through the same medium. Unfortunately, this scenario won't happen soon.

The most commonly mentioned broadcast media are packet radio and cellular communications. These rely on base stations to receive and transmit signals. Coverage, depending on whose service you use, can vary greatly. Ardis, a packet-radio network sponsored by IBM and Motorola, currently operates in over 400 major metropolitan areas through more than 1000 radio base stations. Plans for the next five years call for adding 900 more base stations and "roaming support" equipment (to help people in transit maintain contact). Ardis transmits at speeds of 19,200 bps or 4800 bps.

Ardis's main competitor is RAM Mobile Data, a joint venture of Bellsouth Enterprises and RAM Broadcasting. RAM Mobile Data has links in the 50 largest metropolitan areas and plans to increase that to 100 by mid-1993. Packet radio in general might be getting a boost soon if the FCC frees another 200 MHz of the radio spectrum for private use, as it is expected to do, according to Anne-Lee Verville, president of IBM's General Sector Division. This would double capacity.

Cellular players include the recently announced consortium of IBM and nine cellular carriers, which includes McCaw Cellular Communications, GTE Mobile Communications, Contel Cellular (owned by GTE), and Bell operating companies (except Bellsouth). The purpose of the consortium is to increase the amount of data traffic this can be carried; packet-radio supporters have been quick to point out cellular's limited capacity, and this move is meant to counter that criticism. The group has announced that field trials of its CelluPlan II service will begin mid-summer in San Jose, California.

Competition in broadcast data services is good for keeping prices down and advancing the technology, but it has its downside. Dave Lunsford, director of advanced portable systems for Dell, says, "The biggest problem is in determining what is going to become the de facto standard way to transmit data. Is it packet radio like RAM Mobile or Ardis, or is it cellular? My guess is that vendors are going to try to offer the capability for both."

Having both options open could be an advantage to users. "If you're buried in a parking garage or the second level of a subbasement and you want to send cellular, you've got a problem. Packet radio will get out, but the signal for cellular is too weak," Lunsford said. Cellular transmits at a continuous 0.5-W signal; packet radio is in the milliwatt range until it actually transmits packets; then it uses a 15- to 20-W blast. However, Nick Kauser, senior vice president and chief technology officer of McCaw, has stated that McCaw might use 1.2 W of power to allow the signal to pass through obstacles.

The business market for wireless data communications is only beginning to heat up. For the consumer, it is a long way off. "[Wireless communications for the consumer] is three more years away. Everyone wants it, but it won't happen until it is affordable, is easy to use, and has a low-power infrastructure," says Gerry Purdy, senior director for portable systems at Phoenix Technologies. No low-cost wireless solution currently exists for hand-held devices. You can buy wireless modems for small computers, but they can cost as much as $2000—obviously too high for a consumer device.

Because the signals need a relatively high amount of energy, minimizing power consumption is more troublesome. "If the hand-held PC is in the 3-pound range, it's going to cost at least a pound—maybe as much as a pound and a half [—of battery to accommodate the wireless modem]. That's about 50 percent of the total weight," says Lunsford. "If you want to get the battery weight down," he adds, "you'll have to have a relay station on practically every street corner" to reduce the power requirements for the signal.

Erecting millions of relay stations won't happen. More likely are continued research and improvements in both the infrastructure and the hardware. The industry seems to be in agreement that low-cost wireless mobile communications will eventually be a reality.

ple points and operate at higher speeds.

The Newton will include a link to allow it to transfer data between the device and desktop systems (i.e., PCs and Macs). In fact, in recognition of the PC's market dominance, Apple is putting more emphasis on the development of a PC link than of a Mac link. The link will operate similarly to LapLink, making a wired connection between the PC and the Newton and running a straight file transfer application. The Newton will support the major PC and Mac text and graphics formats but will limit these as much as possible to save code space. More formats will be added at later dates to accommodate more applications on both platforms.

Seeking a Bigger Market

Apple says the personal computer has achieved limited market penetration. Only 15 percent of American households have one. Studies performed by Apple show that most potential users of a hand-held device want to be able to take notes, sketch, scribble, and make lists. They then want to be able to manipulate and organize these documents, schedule items, keep track of people and appointments, share information, and fax and print documents. These tasks, Apple says, fall into three basic categories: capturing information, transforming it, and communicating it. The Newton can recognize free-form text and graphics; integrate

Apple ARMs Itself

ANDY REDFERN

The processor at the heart of Apple's new Newton technology is the ARM 610—a CPU designed by Advanced RISC Machines in Cambridge, U.K. It was developed by a team of designers who cut their teeth developing systems around the Rockwell 6502. The team, at the time part of the U.K. computer manufacturer Acorn, was not impressed by the 16-bit processors being offered by other manufacturers, so, in 1983, they began to design their own. Apple began evaluating the processor in 1988, and in 1990, it invested in ARM. The company became independent, being jointly owned by Apple, Acorn, and VLSI—one of the chip manufacturers who builds ARM's devices.

Announced last year, the ARM 6 processor (see photo A) is a macro cell consisting of just 33,494 transistors. A macro cell is a design subunit that can be recalled from a VLSI CAD system, allowing it to be tucked into the corner of a piece of silicon, leaving plenty of room for custom design. The ARM 6 macro cell is a full 32-bit processor with 31 registers, 17 of which are available to a programmer. It uses a three-stage pipeline, a hardware multiplier, and a 32-bit barrel shifter to speed up instruction execution. The RISC pedigree is apparent in its having only 10 different instruction types. ARM claims the processor will score 30,000 Dhrystones. (The Dhrystone test runs a mix of instructions to provide a general idea of performance.) This makes it considerably faster than the 40-MHz 68030 in the Mac IIfx, which achieves 10,840 Dhrystones.

As a macro cell, the ARM 6 gives systems developers complete flexibility, allowing them to specify what other system functions should be closely coupled with the processor. Apple specified the ARM 610 as the processor it required; it adds a 4-KB cache, an MMU (memory management unit), and a write buffer to the ARM 6 macro cell. Although the other elements are interesting, it is the MMU that is unique in providing virtual memory control and memory permission access.

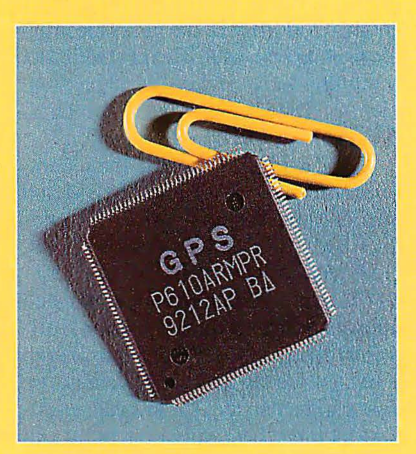


Photo A: *The remarkable size of the ARM 610 is only apparent when compared directly with a universally recognizable object. GPS (GEC Plessey Semiconductors) recently became the second source for the ARM processor range.*

The virtual memory control uses a translation buffer so that recently decoded addresses are quickly available. It also uses a neat trick to provide fast *table walking* for traversing a list of indirect pointers.

Memory permission access may sound a little obscure, but it is actually a core technology that is required to develop a truly object-oriented operating system. The memory controlled by the processor is divided into domains. Client objects can be created in the domain and prevented from manipulating other objects except with permission from the domain manager. This forms the basis of a persistent object store. If an object is referenced but is not in memory, the subsequent fault can be used to activate the code used to fetch that object from the persistent object store.

Persistence is a key concept in creating an object-oriented operating system. Even more crucial from a performance perspective, however, is garbage collection. As an object goes out of scope (dies), it continues to use memory until the memory is freed. Anyone who has used Smalltalk will have experienced the frustration of waiting while the garbage collector frees up the heap space when it's full. The ARM MMU divides the memory into live and dead regions, thus allowing a separate process to garbage-collect the dead memory while an application concurrently uses the live memory space.

The MMU was the key to the ARM/Apple relationship. In working with Apple's software designers, the ARM engineers created the level of hardware support that the software required. But the advantages of the ARM technology for Apple go beyond the design.

A major consideration for Apple was the unusual measure of MIPS/milliamperes. Desktop systems designers tend not to worry about the power consumption of the processor, but any portable system needs to be power-thrifty in order to preserve battery life. The ARM 610 uses some neat power-saving tricks that allow it to deliver 0.10 MIPS/mA (an Intel 960 delivers around 0.02).

Another important factor for Apple was the size of the processor. Small, portable devices require miniaturized surface-mount components. The ARM 610 is just 1.4 millimeters thick and 22 mm square and comes in a 144-pin TQFP (thin quad flat-pack). The actual silicon inside is back-lapped (i.e., ground down) to make it small enough to fit in the package. Even then the walls of the package are so thin that they don't provide a hermetic seal, so the silicon has to be specially coated before packaging.

Perhaps even more impressive is the time scale within which the ARM 610 was developed. From specification to delivery of complete silicon took just four months. Small wonder that ARM succeeded where others have failed—that is, in being the first U.K. company to have its CPU included in a mass-market product.

that data into a scheduler and address book; and print, fax, and communicate that data to PCs and Macs.

Apple says the Newton's value comes from its unique user interface, which is tightly tied to the hardware—traditional Apple strengths. Apple believes that most people are looking for a set of very specific, highly customizable capabilities rather than the heavyweight general applications available today on PCs.

In a reversal of past practices, Apple is licensing the technology in the Newton to third parties to help broaden the market. Sharp and other companies have already got licenses, and Apple expects at least one other company to launch a product based on the technology within a year of Newton's launch. Apple plans to have the Newton in production in January 1993 at a price under $1000; one source at Apple says it could quickly fall to $500.

Two Different Apples

The Newton is a bold new initiative for Apple. It works with Apple's existing products but otherwise has little in common with them. In fact, Apple is willing to support interconnection with the IBM PC standard more aggressively than with its own Macintosh products. This is not a problem, says Nick Baran, editor of the industry newsletter *Pen-Based Computing*. The Newton is a totally new product, "so any criticism of Apple for abandoning its user base is irrelevant."

Apple's Tesler says that subsequent Newton products will migrate away from being business tools and toward being purely consumer electronics devices. He acknowledges that games will play an important role.

Creative Strategies International's Bajarin thinks that Apple has an excellent chance of making the Newton succeed across different markets. Says Bajarin, "Apple is the only company that can participate in the digital [consumer electronics] revolution across the board—from the business to consumer market."

Dell and Gateway: The Road Well Traveled

Compared to Newton's radical design, Dell's and Gateway's new subnotebooks are conservative. Yet all three have the same goal: to make computers as personal and portable as possible. But while Apple is using an entirely new paradigm, Dell and Gateway rely on proven conventional design to deliver the best that can reasonably be expected today from a notebook PC.

Like the 386 notebooks of the past few years, the 3½-pound Dell 320SLi (see photo 2) is a powerful, potentially desktop-replacing machine that doesn't compromise on processing power, display, hard drive space, and keyboard layout. The Gateway 2000 Handbook (see photo 3) uses Chips & Technologies' PC/Chip CPU (roughly equivalent to a 16-MHz 286) and sacrifices a bit on the screen and keyboard. But the Handbook is smaller and nearly a pound lighter than the 320SLi. Despite the familiar feature lists, they represent the next wave in practical, mobile computers.

The 320SLi crams a 20-MHz 386SL, a 2½-inch 60-MB IDE hard drive, and up to 10 MB of system RAM into a tiny package

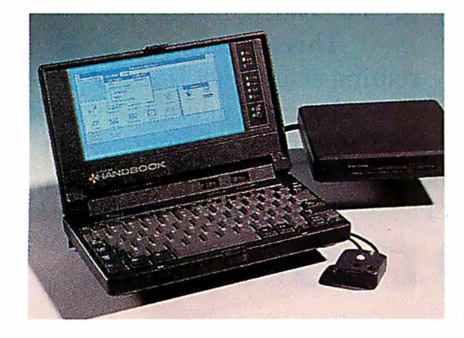


Photo 2: *The Dell 320SLi is a robust 4-pound subnotebook. Its performance and many of its components match those of heavier 386-based notebooks.*



Photo 3: *The Gateway 2000 Handbook is less powerful than the Dell 320SLi but is smaller, lighter, and about $1000 less. The Handbook's PC/Chip CPU is comparable to a 16-MHz 286, but it can run Windows 3.0 reasonably well.*

that measures 7¾ by 11 by 1¼ inches. In contrast, the Handbook uses a 2½-inch 40-MB hard drive (splayed open to reduce height) and has a maximum 3 MB of system memory, but it is truly diminutive for a notebook at only 5 9/10 by 9⅘ by 1⅖ inches. The 320SLi's keyboard is a full-size 85-key layout, designed with a 3-millimeter key travel—exactly the same component used on Dell's larger notebooks. In fact, Dell's inclusion of the standard-size keyboard was one of the major constraints on the 320SLi's size. Gateway trimmed the Handbook's size by using a 78-key keyboard; it is acceptable, but not as good as Dell's.

The 320SLi's other full-size component is its 9½-inch VGA LCD. Although it's not backlit, Dell claims an impressive 12-to-1 contrast ratio, similar to that of current backlit technology. The 64-gray-scale screen is easy to read even in poor lighting conditions. The LCD fits into a lid that's remarkably thin, at only 3/10 inch. The Sharp-manufactured glass panel is mounted directly in its plastic housing, avoiding the added weight of a metal frame. The 320SLi sports a full range of external ports.

Gateway backlights its screen, but the Handbook uses 7⅗-inch double-scan CGA video to achieve its small size. Although graphics and text are "squashed" due to the fewer horizontal lines, the trade-off of high-resolution video for portability is reasonable. The Handbook also has a full complement of external ports.

Neither system has a built-in floppy drive. Instead, the 320SLi packs a single PCMCIA 2.0 memory-card socket, which is its primary gateway to external data. If you want to install an internal modem or network adapter, you'll need to use the PCMCIA socket. The Handbook has no PCMCIA slot and relies on external add-ons. Dell includes an incredibly compact external floppy drive as part of the standard 320SLi package; the drive is not much larger than a 3½-inch floppy disk. Gateway's optional floppy drive is about twice the size of Dell's.

Reduced battery size is a major contribution to trimming overall size and weight. Both the 320SLi and the Handbook are powered by nickel-metal-hydride batteries, with claimed battery lives of 3 and 4 hours, respectively. The 60-MB 320SLi will sell for $2199 and the Handbook for $1295. Both were scheduled to be available by the end of June.

The Companion PC: Living Up to Its Name?

Phoenix Technologies hopes that its Companion PC will be a success not only with current computer users but with everyone else, too. The company, which will not actually build the systems but will instead license the design to others, is banking on three factors to break into the general consumer market: small size, low price, and easy-to-use embedded software.

The embedded software sets the Companion PC apart from the Dell and Gateway systems. It supplies the basic popular

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applications—communications (a fax modem is built in), word processing, and database management—with the added dimension of ease of use by insulating users from the operating system. This software suite, written by Lotus Development, "brings the functionality of a spreadsheet, database manager, and word processor into the PIM [personal information manager] world," says Gerry Purdy, senior director for portable systems at Phoenix Technologies. Usually, the PIM must adapt to work with the popular products for those applications. In the Companion PC, all function in a common environment. Phoenix Technologies expects that most systems based on the Companion PC will sell in the $600 range. Many will be sold through mass-market channels.

The Interface Is Key

The winner in the race to provide a mobile electronic helper for the rest of us will be the first to design a truly intuitive interface. Newton is a step in that direction, but the ultimate device will be as familiar and easy to use as a notebook—a paper one, that is—and a telephone. ■

This article is the result of a joint effort by five BYTE editors. Senior News Editor Owen Linderholm reported on the Apple Newton from BYTE's San Francisco office. Senior Editor Michael Nadeau and Technical Editor Steve Apiki covered the Dell, Gateway 2000, and Companion PC systems from our Peterborough, New Hampshire, headquarters. Nadeau and News Editor Ed Perratore from BYTE's New York office wrote about enabling technologies. Finally, Andy Redfern, our London bureau chief, interviewed the ARM folks on the Newton's CPU.

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fax: (512) 338-8700
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Gateway 2000, Inc.
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(800) 523-2000
(605) 232-2000
Circle 1138 on Inquiry Card.

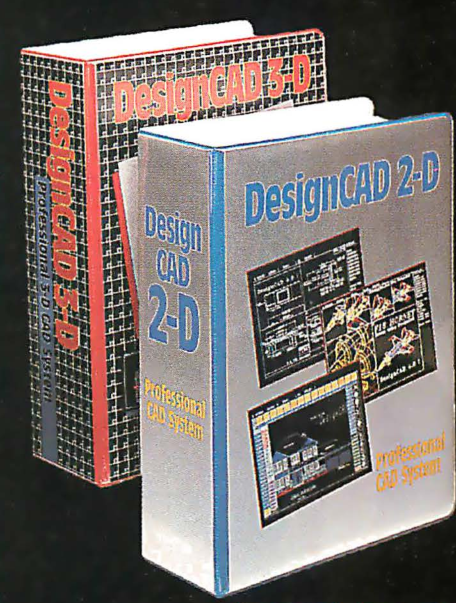
Hewlett-Packard Co.
(HP 95LX, Kittyhawk)
3000 Hanover St.
Palo Alto, CA 94304
(800) 752-0900
(415) 857-1501
Circle 1139 on Inquiry Card.

MiniStor Peripherals Corp.
(1.8-inch hard drives)
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San Jose, CA 95134
(408) 943-0165
fax: (408) 434-0784
Circle 1140 on Inquiry Card.

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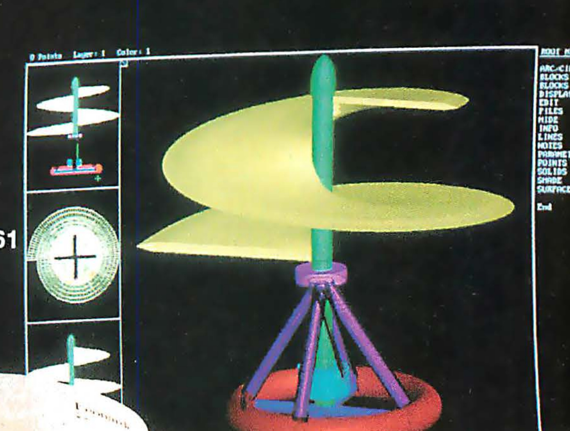


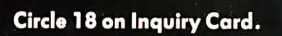
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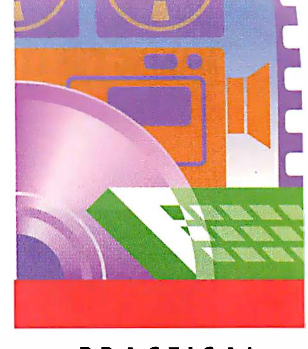
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PRACTICAL DESKTOP VIDEO PART 4

Making the Cut

In the end, the success of your desktop video productions hinges on editing

TOM YAGER

You've shot your video, collected your various graphics, and perhaps even added some original animation. Now comes the most important task in desktop video production: editing.

It's during the editing process that the unconnected mishmash of raw materials you've amassed becomes a cohesive unit. Regardless of the care you exercise in shooting and planning, only a well-executed edit will result in a quality video. It's also during this process that you blend audio and graphics overlays into your video.

In addition to being the most important part of desktop video production, editing is, in many ways, the most demanding. Therefore, this article is the longest and most technical of the series. I've packed a lot of information into this small space and have had to leave out some details so that you can view the editing process from beginning to end.

Timecode and Striping

One thing that sets a professional editing system apart from one built on low-cost, consumer-quality components is *accuracy*—the relative ability of a VCR's transport mechanism to position itself at a specified location on the tape. Your home VCR probably has either a simple counter or elapsed play time to display the tape's position. These features roughly measure the movement of the tape through the machine, and they vary in accuracy depending on implementation. Don't expect them to represent the tape's position to an accuracy of better than 1 second.

A second doesn't seem like much, but when you're editing, it can be an eternity. This becomes particularly evident when you edit footage of a person talking. A second or more of slop can have you cutting in on an awkward facial expression or some background annoyance. Editing video that was shot hand-held (or, as I recommended, with a Steadicam JR) often requires precision to cut in after the camera is stabilized and out again before the camera rattles into position for the next shot.

Timecode, a digital marking that precisely identifies each video frame on a tape, solves the problem of achieving positional accuracy. Quality video decks can read this digital code as you play the tape or record material onto it; thus, the deck's transports can accurately locate a specific frame. The process of recording timecode to a tape is called striping, and how and when you stripe your tape depends on how your facility is set up. Professional editing VCRs, such as the ones in the BYTE Multimedia Lab, offer built-in timecode reader/generators as either a standard feature or an option. These decks can record timecode in one of two ways: either as a video signal placed in the invisible vertical (blanking) interval (i.e., the space between video frames) or as an audio signal recorded to one of the deck's audio channels. The latter is most common for desktop video applications, and it is also the approach that external timecode generators use.

You can stripe timecode onto a tape before, during, or after you record video material. You should prestripe the tape you plan to record in an editing session; remember that editing calls not only for precise location of segments on the playback tape but also for accurate positioning of edits on the recorder. Prestriping creates a timecode reference (usually on the audio track) that is not erased during recording.

When you stripe a tape, you must also record a video signal. Black video generated by a computer graphics card, a camera with its lens cap on, or an

BYTE ACTION SUMMARY

The editing process is what separates good video from bad. Good editing requires the precision of high-quality equipment that supports timecode and external sync. In addition to cuts and transitions between different pieces of video, editing also involves adding graphics, titles, and audio to create a polished presentation video.

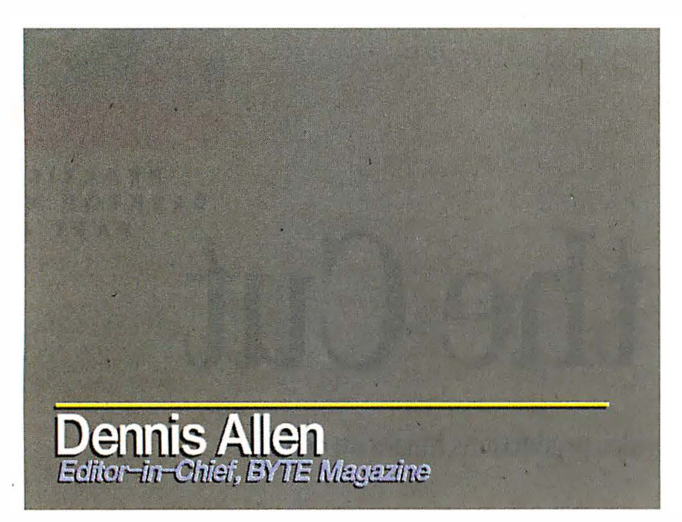


Photo 1: *The first step in video titling is creating a graphics file with a background made up of the key color—in this case, black.*



Photo 2: *When shooting the video, you should position your subject so that the title will not obscure anything significant in the frame.*

external sync unit is usually the best choice. The combination of black video and timecode should extend at least as far as the total anticipated length of your video. I tend to prestripe fresh tapes from beginning to end right after I unwrap them; it's a lot like formatting a disk.

Professional editing decks are frame-accurate. They can read and write timecode, and their controlling electronics let them start and stop recording exactly on specified timecode locations. Quality decks can perform single-frame edits in which only one frame of video is recorded in perfect sync with the frame that preceded it. Single-frame edits are used primarily in recording animations.

Getting in Sync

Frame-accurate positioning is only one element of a clean, accurate editing system. Frames of video are recorded onto a tape in rapid succession, following a predictable pattern with a precise rhythm called *sync*. Where timecode handles the timing *between* frames, sync handles it *within* each frame. To make a clean cut from one video frame to another, you must make sure that the beginning of a new frame of video precisely abuts the end of a preceding frame. Missing a frame's boundary will throw off the rhythm of a video frame, producing poor results. Poor sync is at the root of many bad-looking edits and is something that you can't fix later.

You need to synchronize every video device you use in your editing session. To do this, you have to select a master sync source that determines the video timing of all your devices. The source should provide an uninterrupted video signal. Plenty of qualified sources are available, including video cameras. Suppliers of professional video equipment offer small, fairly inexpensive "black boxes" that supply sync.

In the Lab (as in any facility where the equipment is reconfigured frequently), the best source for a sync signal is a dedicated one. The Diaquest DQ-422 VCR controller in the Lab's PC puts out perfect, uninterrupted sync. I use this source even when the PC is not directly used in the edit to save me considerable recabling when I switch from one configuration to another.

Once you've identified a viable master sync source, you must lock all the video devices you plan to use onto that source. For some types of devices, this is easy: The Lab's Truevision video cards (NuVista+ and ATVista) can automatically synchronize their video signals to an external source to cleanly overlay video with computer-generated graphics. Some video cameras, too, can lock into an external sync source. Video cameras and graphics cards can adjust their video timing internally. The process of synchronizing a camera or graphics card to an external signal is called *genlock*.

A more difficult problem occurs with videotape. Unlike genlockable sources, videotape possesses its own unalterable sync, laid down when you make a recording. To synchronize a VCR or any device that isn't inherently genlockable, you need a TBC (time-base corrector). A TBC electronically shifts the start of each recorded video frame to coincide with the timing taken from an external video signal. It also makes an electronic recording of each video frame and plays that frame back when it sees the start of the sync source's frame. Most TBCs let you adjust certain aspects of the video that they synchronize (e.g., color saturation and hue).

The drawback to TBCs is their cost: You should plan on spending about $1000 for each video source that requires time-base correction. This price buys either an external unit, which may contain multiple TBCs, or an expansion card (with one TBC) that plugs into your computer. Remember, though, that you don't have to use a TBC for any device that supports genlock. The Panasonic AG-7650 S-VHS player and AG-7750 recorder both have built-in TBCs; this feature played a pivotal role in my decision to use these decks.

Once you've figured out how to synchronize the devices in your setup, you must make the physical connections between them. The physical wiring for sync of a video suite is often referred to as a *sync network*. If you've ever hooked up a computer network, you'll find the process surprisingly similar.

A sync network starts at the master source and ends with the last device in the chain. Like any network, it must have a terminating resistor at the end of the wire. How the termination is handled depends on the device. The Panasonic VCRs will either pass through reference sync to the next device in the chain or, at the flip of a switch, terminate the sync network. Some devices, however, *always* terminate. If you have only one terminating device, you can place it at the end of your sync chain. If you have more than one or if your sync network needs to handle many devices, you can use a distribution amplifier to split your master sync signal into multiple outputs that you can terminate individually.

continued

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Charges for training time	6.43	5.60	5.71
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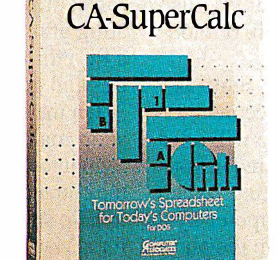
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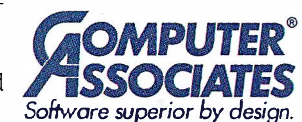
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Photo 3: *Wherever the key color appears in the graphic, the video shows through when you overlay the graphic on the video.*

Editing Types and Setups

How you connect video outputs and inputs depends on the type of editing you plan to do and the mix of equipment you've got. Generally, the more elements you roll into a video, the more complicated the connections get. Here are just some of the methods possible with an affordable desktop video production setup.

The simplest editing method is called *cuts only*, so named for the abrupt transition between edited scenes. The new scene simply replaces the old one. If you watch a TV program or a film, you'll notice that the vast majority of edits are cuts. It is, therefore, perfectly reasonable to use a cuts-only system as your exclusive means of video editing.

The simplicity of cuts-only editing is evident in the process of interconnection and execution. With interconnection, you can limit the video equipment to two units: the player and the recorder. If the edit doesn't call for computer-generated graphics, the connection is easy: You just patch the video and audio outputs of the player directly into the inputs of the recorder. In the case of the AG-7650 and AG-7750, the decks' internal TBCs ensure that they are synchronized. You can use an external sync source if you wish.

Execution of an edit in a cuts-only system requires only one unit: the player. A single-edit event consists of an in point and an out point, both identified by timecode. You need in and out points for the player and the recorder. Also, while the duration between the in and out points should match, the player's and the recorder's timecodes don't need to be the same. Thus, you can reduce a cuts-only edit session to a list of pairs of numbers representing the player's and the recorder's in and out points. Editing software, such as you'd find on dedicated video-editing consoles, lets you mark your in and out points interactively. The software then sends commands to the video decks to carry out the edits. It also lets you maintain a list of edits that you can save, recall, or modify at will.

Adding graphics to your video complicates your setup because you can no longer simply wire your player and recorder together. Edits get more complicated, too, because some will refer to material on your playback tape, others to graphics stored in your computer, and still others to combinations of the two (e.g., when titles overlay recorded video). The Lab's three computer systems use pass-through, in which the video output from the playback deck is connected to the video card's input. The card's output is then connected to the record deck. For ordinary edits (i.e., cuts), the card passes the player's video signal through to the recorder without modifying it. When graphics are involved, the graphics card either replaces or enhances the playback video.

This setup, involving one video playback source and including computer-generated graphics, is something I call *modified cuts-only*. Going from one video scene to another must be done as a cut, but transitions between graphics and video can often include special effects. I don't have room here to launch into a discussion of these effects. My reviews of the Newtek Video Toaster (see "Newtek's Video Toaster Makes Professional Video Affordable," March 1991 BYTE) and the AT&T GSL (Graphics Software Labs) StudioMaster Pro (see "Edit Video at Your Desk," May BYTE) cover them in more detail. Suffice it to say that, when used in moderation, transitional effects are a nice alternative to dry cuts.

A modified cuts-only system represents the most cost-effective way of putting the editing portion of a desktop video production system together. The other alternative is an A/B roll, which involves adding a second source deck. (This can go on to an A/B/C roll and so on.) An A/B roll system requires a computer-controlled device (e.g., the Toaster) that switches between multiple video inputs. With the system, you can apply transitional effects to edits between two video segments. An A/B roll system is considerably more difficult to manage than a modified cuts-only system, and I think the latter system best serves most budding video producers.

Feast Your Eyes

Some of the raw materials that make up a completed video don't exist in final form until you're ready to edit. Among these are overlay graphics (including titles) and additional audio. I'll discuss the audio later.

Compared to other computer-generated graphics, overlay graphics require some special considerations. The most common type of graphical overlay is the title, which is often used to identify the person or thing on-screen or to add other textual information without obscuring the video playing underneath.

When you combine video and graphics, the graphics usually occupy the foreground and fully or partially obscure the underlying video. This is easy to manage on most systems. With the Truevision cards, you can define a *key color* for each graphic. Wherever the key color appears in the graphic, the underlying video shows through. For example, if you set your key color to black and create a graphic of white letters on a black background, the black background will disappear when you execute your edit, and the letters will seem to float on top of the video (see photos 1, 2, and 3). The Toaster doesn't use key colors; it uses brightness (luminance) to determine which portions of the graphics show through to the video. In effect, this limits you to two key colors: black and white.

On the Lab's PC, I use AT&T GSL's RIO to generate my titles. In fact, I like the quality of RIO's output so much that I often export RIO graphics to the Lab's Mac and Amiga. The scalable fonts, drawing tools, and antialiasing make RIO perfect for creating graphics intended for overlay. Unfortunately, I don't have a PC editing system that lets me automatically integrate RIO titles and graphics into my videos.

On the Mac, I use various tools. Adobe Illustrator and Photoshop make a good combination for most titling/overlay jobs. Symantec's More makes quick work of simple layouts. Running the output through Ray Dream's JAG software applies antialiasing to help smooth things out. To prepare a title or graphical overlay for a Mac-based editing session, I only need to save or convert my output to PICT format.

continued

The Amiga probably has more titling packages available for it than the Mac and the PC combined. Because I'm concerned with quality results, I use the Toaster's CG (character-generator) module. It lacks scalable fonts, but it comes with a huge assortment of bit-mapped fonts and a lot of third-party font support. The Toaster CG also does crawls (i.e., horizontal rolling of text across the screen) and scrolls (i.e., vertical rolling of text).

Cut!

A computer's ability to automate a video-editing session is certainly one of the leading reasons desktop video production has become so popular. Two editing systems in the Lab are housed in the Mac and the Amiga.

The Mac-based system runs AT&T GSL's StudioMaster Pro. The package takes an almost entirely graphical approach to editing. It represents playback in and out points not only with timecode but with postage-stamp icons that are taken from the video. StudioMaster Pro uses the Diaquest DQ-Animaq to control the Lab's two Panasonic VCRs and the Truevision NuVista+ card for graphics and overlays. Of the Lab's two editing software systems, StudioMaster Pro is the simplest to understand and operate. Graphics and graphical overlays are PICT files, and edits involving overlay graphics show a user-selectable key color. StudioMaster Pro can also apply simple transitional effects between scenes; thus, it offers some of the benefits of an A/B roll editing system.

If StudioMaster Pro's trump card is its simplicity, the Amiga-based editing system can claim versatility as its domain. RGB Computer and Video's AmiLink VT is a Toaster add-on that provides VCR control, editing software, and automatic control of the Toaster's switcher module. It relies on Videomedia's V-LAN system to control the VCRs.

AmiLink VT is more difficult to learn and use than StudioMaster Pro is, but it's more capable. In addition to the Toaster's four video inputs, AmiLink VT can use the Toaster's dual framestores (i.e., graphics buffers), background color generator, and CG as video sources. Each edit gets a page of its own that details in and out points, video sources selected, the transitional effect (if any), and the name of the CG page or framestore image used (the Toaster identifies these numerically).

Between the two editing systems, I'd nod toward combining the AmiLink VT and the Toaster. The AmiLink VT can handle future expansion of your facility. There's also room in the V-LAN standard to control devices other than VCRs, including audio mixers and external video switchers. In the Lab's modified cuts-only configuration, the AmiLink VT proved to be a stable and competent editing system.

Grab 'Em by the Ears

Because camcorders record audio along with video, you might wonder what more audio you need. Additional audio adds punch to your video and reinforces your message. Equipping your desktop video production setup for external audio takes a little doing, but it's worth it.

Music appropriate for professional video doesn't grow on trees. You can use prerecorded commercial music for a fee, but it can be expensive and difficult to arrange. A far better choice is canned production music. Killer Tracks is one of several companies that create music for use with video and distribute it on high-quality CDs.

One alternative to CD production music is a MIDI file. Using MIDI, you gain control over the song's tempo, length, instruments, and mix. In effect, MIDI is a 16-track digital recording, so the depth and quality of the music is virtually boundless.

Using MIDI music in a video requires a PC equipped with an internal MIDI controller or sound-generating card or an Amiga or a Mac equipped with an inexpensive MIDI box connected to its serial port. You need two kinds of software: the MIDI data and the sequencer that creates and controls it.

In sequencers, I've found no equal to Blue Ribbon Soundworks' Bars & Pipes Professional for the Amiga. Its interface is easy to understand and so extensible that people at any musical level will feel comfortable with it. It processes music in real time, and its time-line orientation supports sync to timecode. It can trigger MIDI and other events at precise frame locations, making it easy to synchronize your audio and video.

A computer's ability to automate a video-editing session is one of the leading reasons desktop video production has become so popular.

The sequencer I use most frequently on the Mac and PC is Master Tracks Pro from Passport Designs. This package offers quick access to the parameters you'd most likely change in a piece of canned MIDI music: tempo, instruments, and duration. While it lacks the ease of use and breadth of the Bars & Pipes Professional arsenal of real-time tools, Master Tracks Pro has enough power to put you solidly in control of any MIDI music you buy or create.

If you're fortunate enough to have a keyboard musician on staff, you might coax him or her into recording some music for your video. You can also use a notation program, such as Midisoft's Studio for Windows, to turn sheet music into MIDI files. But if you aren't musically gifted, it's probably best to stick to canned MIDI files.

Voyetra Technologies is one of many companies offering MIDI production music. Voyetra's MIDI files come premixed for the Roland SC-55 Sound Canvas, a MIDI sound module that uses digital sampling and internal effects to produce rich, realistic instrument sounds. This is the best-sounding module I've used, and it has dozens of ROM-based instrument sounds to choose from.

If you want complete control over the shape of your video production music, the best electronic instrument I know of is the Ensoniq EPS 16 Plus. This digital-sampling keyboard produces music by playing back digital recordings. Its grand piano and orchestral voices are strikingly realistic, its drum sounds range from techno-pop to hot and heavy, and its built-in effects unit makes its output glow. The EPS 16 Plus has a built-in 8-track sequencer that is powerful enough to obviate the need for host-computer MIDI gear and software. It also contains an internal floppy drive that it uses to store instrument and sequencer files. What sets the EPS 16 Plus apart from other synthesizers is its ability to record sounds and use them as instruments. You can use it to



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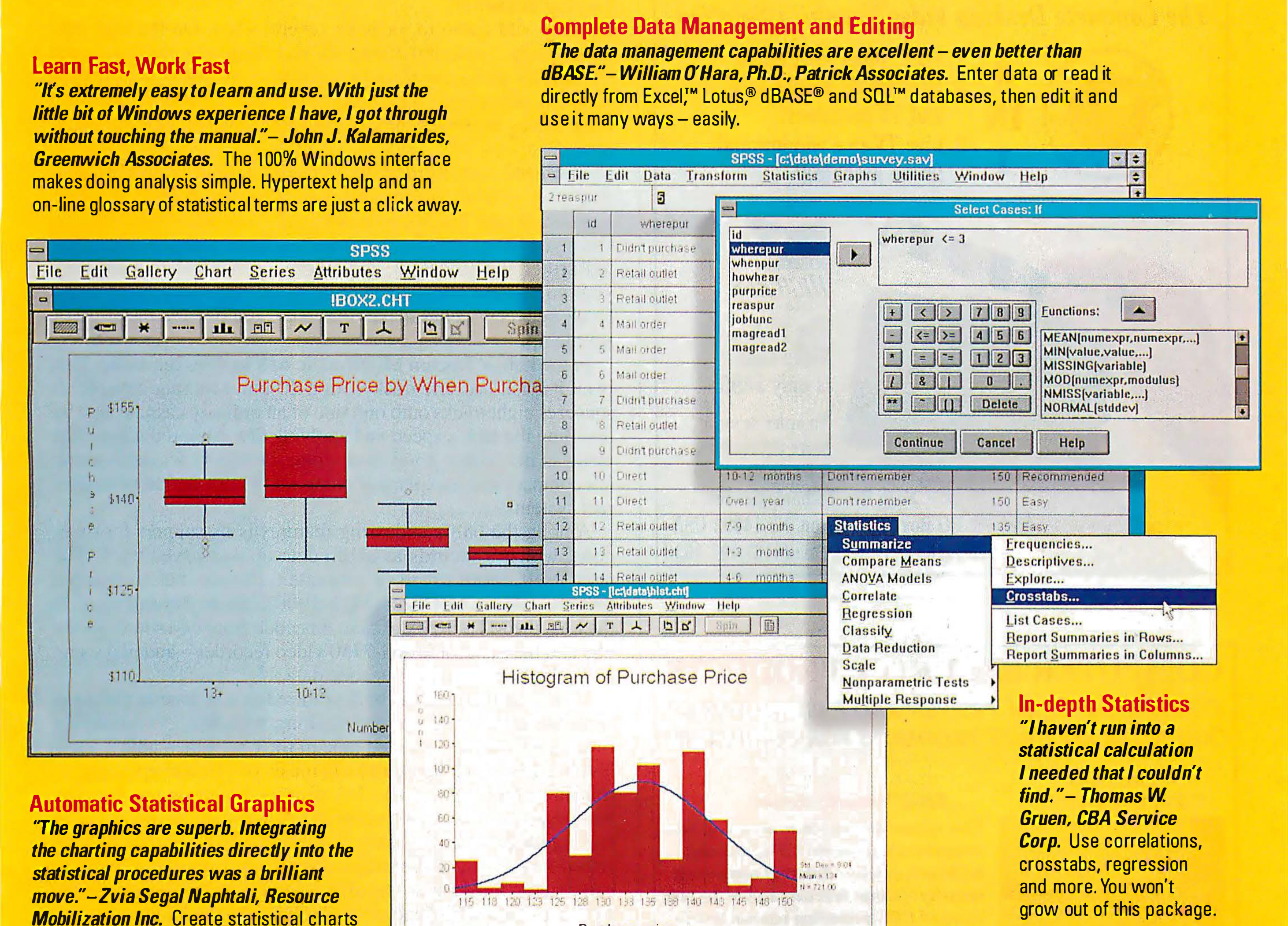
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record sound effects, "borrow" instruments from other synthesizers, or even do short voice-overs, all under the exacting control of either your computer or the EPS 16 Plus's built-in sequencer.

Laying It Down

You can add audio to video in several ways. On the high end are professional digital multitrack recording systems that record CD-quality audio directly to your computer's hard disk and play it back in perfect sync with your video. More affordable, however, is the analog equivalent of this approach: the multitrack audiotape recorder.

You need a multitrack deck to add audio to video because you must reserve one or two tracks for the video's original soundtrack (the one recorded by your camcorder, most likely). Once you have captured the video's original audio, you can add to it, filter and process it, and otherwise manipulate it any way your equipment allows. Even the simple equalization of audio levels between scenes makes outbound audio worth the effort of setting up.

In the Lab, a Tascam MIDIStudio 688 handles the audio. This is an 8-track cassette deck with a 20-input mixing console. It squeezes eight tracks onto one side of an ordinary cassette tape by doubling the tape's speed and applying dbx noise reduction. The result is incredibly good, and while the 688 is no lightweight, it's compact and inexpensive compared to full-digital or reel-to-reel systems.

Among the 688's endearing features is its support for timecode, which it records as audio data on a reserved track. The deck itself doesn't read or generate timecode, but an external unit, the Tascam MIDIizer (MTS-1000), can do that and more. In the Lab, the MTS-1000 takes in timecode from two sources—the 688 and the Panasonic AG-7750 video recorder—and plays several roles based on the timecode data.

I handle audio after the bulk of the editing is done so that I can send the entire audio program along with the accompanying timecode from the recorded tape to the 688. I then adjust audio levels, add audio effects, and add music or voice-overs using the remaining five audio tracks left after the timecode and the original stereo soundtrack are recorded. If you work in stereo, those five tracks disappear quickly: I reserved two tracks for the final stereo mix-down (I'll explain that shortly), used two more to carry stereo music or sound effects, and used the remaining one for voice-overs. This scheme works, but it can be limiting. For example, you can't effectively cross-fade between two pieces of music. Unless you know that your video will often be shown on a stereo-capable system, expending the effort to preserve full stereo may not pay off.

Another common use for external audio in video is for voice-overs. A multitrack recorder makes these easy, but remember that some voices record well and others don't. Professional voice talent needn't be expensive, and it can be as close as your local radio station.

Once you've got your music and voice-overs laid down on tape, you need to do the mix-down. For a very short tape or simple mix, you can probably get away with mixing down directly to the video recorder. The 688 doesn't use any automated mixing, but it does let you cut tracks in or out under MIDI control. For more complicated mixes, you'll want to mix down to a reserved track (or pair of tracks) on your recorder. You'll need to script out the mix-down, detailing which volume sliders come up or down at specified timecodes. Don't try anything too fancy—you only have two hands. If you are lucky, you can do a scripted mix-down in one take, although you'll probably have to make subsequent passes, using moments of silence to punch in and record

continued

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over mistakes.

In the Lab, moving the mixed-down audio back to the videotape was relatively easy. I put the edited videotape in the AG-7650 player and connected its timecode output to the master timecode input on the MTS-1000 MIDIizer. I then connected the 688's timecode output to the MTS-1000's slave timecode port. I also connected the video output from the player to the input of the recorder and hooked the audio line outputs of the 688 to the audio inputs on the recorder.

When I pushed the play button on the AG-7650, the MTS-1000 went into chase mode and compared the moving timecode from the video with the copy of it recorded on the 688. The MTS-1000 then commanded the 688's transport to chase to the matching timecode location. Once it found it, the MTS-1000 kept the video and audio timecode perfectly locked and made minute changes to the audiotape speed to keep it exactly in step with the video. After the video ran to the end, the recorder held a copy of it complete with the enhanced audio, with the original audio in perfect sync.

It's a Wrap

The information presented in this series has taken almost two years to accumulate, yet it represents only a part of the total desktop video production story. New products and technologies are expanding the reach of desktop video production while at the same time making it less expensive and more accessible to a wide variety of organizations.

The Multimedia Lab series on desktop video production is your guide to making decisions about desktop video. It answers basic questions: Is it for you? What platform is best? What software and hardware do you need? It also gives you a hands-on guide to this powerful multimedia technology. Desktop video production puts the persuasive power of video in everyone's hands. Now it's in yours. ■

Tom Yager is the director of BYTE's Multimedia Lab and author of the upcoming book The Multimedia Producer's Handbook *(Academic Press, forthcoming). He can be reached on BIX as "tyager" and on the Internet at tyager@bytepb.byte.com.*

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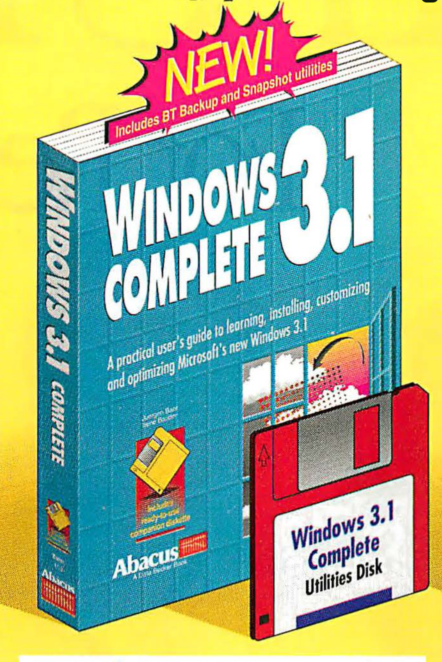
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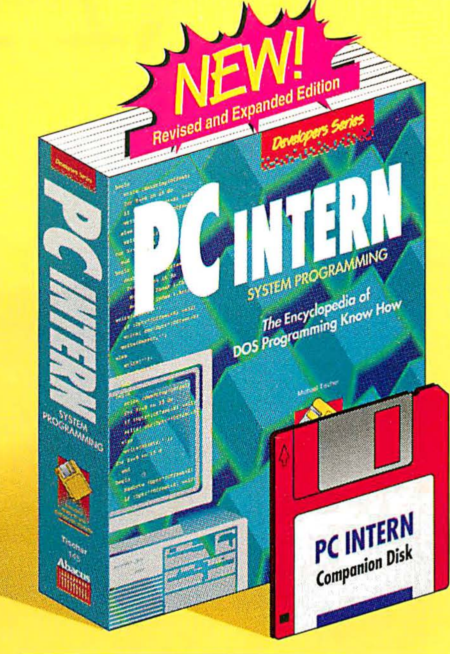
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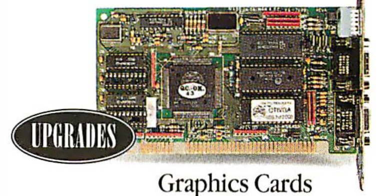
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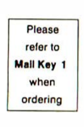


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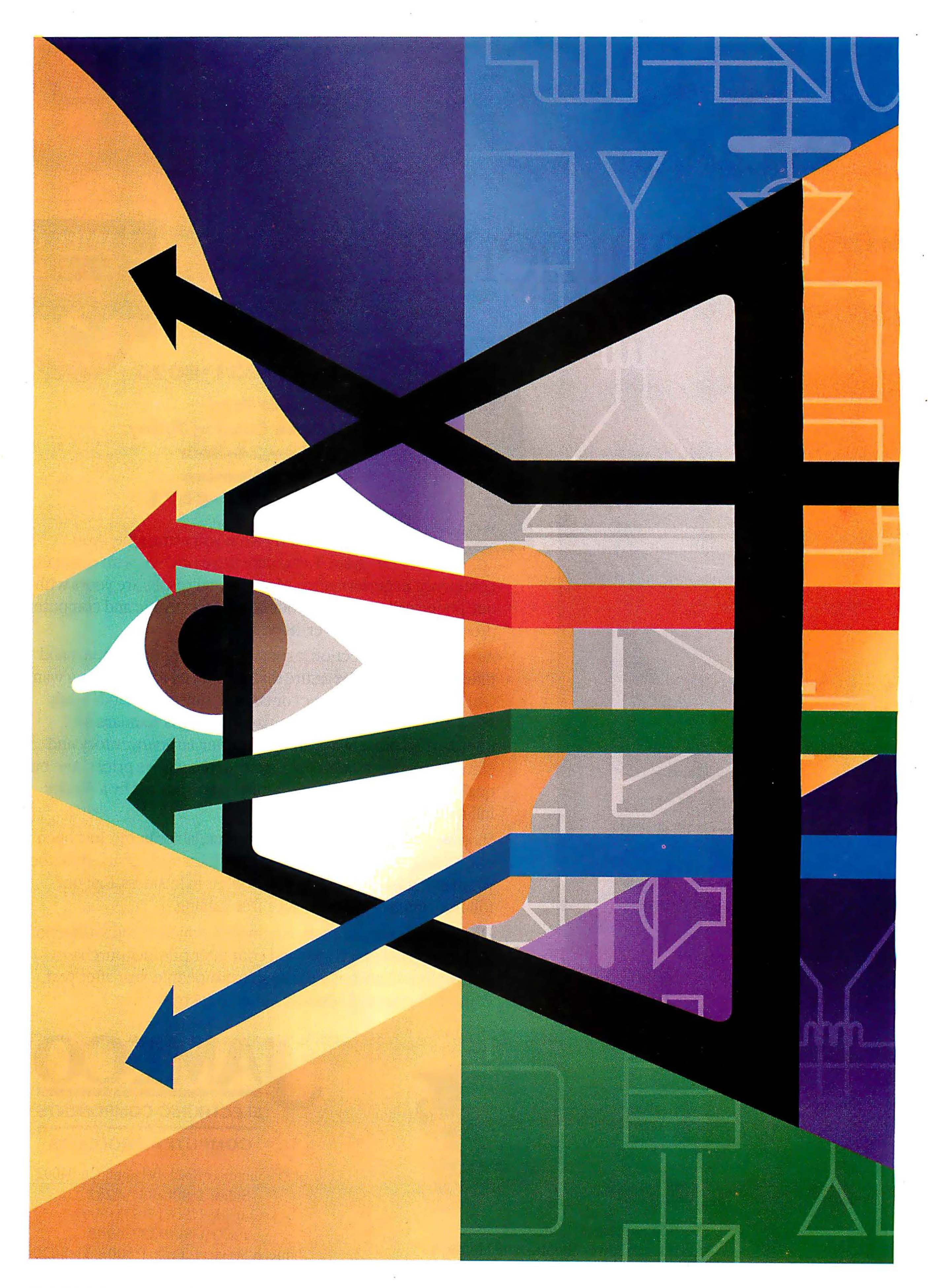


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DISPLAY TECHNOLOGIES

CRTs are here to stay, but many other types of exciting displays are becoming available

OLLIE C. WOODARD SR. AND TOM LONG

Living in the information age requires tools that best allow you to find, assimilate, and act on the data that you need. The easiest way you acquire information is with your eyes. That makes your computer's display a vital part of your system.

Computer makers are relying more and more on the display as an interactive control element. Unlike most other system components, however, a display's internal workings may be a mystery to you. Few people have the confidence (or foolishness) to open the sealed box that holds the CRT, LCD, or plasma mechanisms.

The simple readouts of earlier computers have been replaced by multiple windows of information containing graphics, video, and interactive menus and controls, as well as the typical alphanumerics. Because of the emphasis on multimedia, displays must be larger, provide better contrast and color, and have higher resolutions. It's also essential that they be ergonomically and aesthetically pleasing to the operator. This appropriate combination of features provides the best display image for your applications. (See "Color and Resolution" on page 171.)

You can categorize displays into two types: light-source, or emissive, displays and light-valve displays. CRTs are light-source displays because they generate the light that forms an image by selectively lighting the display's pixels (see the figure). LCDs are light-valve displays: Their pixels selectively transmit or block ambient lighting or backlighting to form an image.

Most displays are built around CRT technology because it is inexpensive and has nice features. However, the growing need for other types of displays has created demands for different technologies. FPDs (flat-panel displays) are used for a number of applications. For example, manufacturers have introduced LCDs in the proliferating laptop, notebook, and palmtop computer markets. Manufacturers are also using other kinds of FPDs (e.g., plasma, electroluminescent, and vacuum-fluorescent displays) in other applications.

The following is a discussion of the benefits and trade-offs of current display technologies. We'll also examine some of the issues surrounding new and emerging displays.

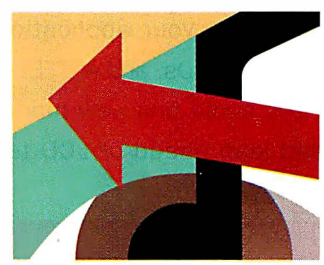
In the Beginning

CRTs are still the most prevalent display technology. Millions of TV sets, computers, and workstations throughout the world have CRT displays. CRTs are the standard that newer technologies must beat. They offer good brightness, contrast, colors, resolution, and reliability, as well as a wide viewing angle—all at a low cost. No other technology for workstation-size displays is competitive in both price and performance.

However, a CRT takes up a lot of space. Its depth is roughly equal to its screen's diagonal dimension. CRTs are also heavy and consume considerable power. They produce x-rays and low-frequency magnetic fields that are suspected of causing health hazards for full-time terminal operators. On the other hand, FPDs produce no x-rays or magnetic fields.

Coming into Being

The chief virtues of FPDs are their low weight, thin profile, and low power consumption. In a short time, new applications requiring the advantages



PERFORMANCE OF LCD PRODUCTS

Table 1: *AMLCDs provide color, good contrast, and high brightness at the expense of backlight power. The PALC AMLCD and the FLCD also perform well and may become less expensive replacements for TFT AMLCDs. Compared to the other LCDs, the STNLCD costs less, but it's slower, is not as bright, has lower contrast, and is suitable for use as a computer screen but not as a TV screen.*

	LCD type			
	OIS AMLCD (TFT)	**Tekvision AMLCD (PALC)**	**Canon PMLCD (Ferroelectric)**	**Kyocera STNLCD**
Diagonal size (inches)	10	10	15	10 7/10
Required power (W)	65	39	N/A	8
Resolution (pixels)	640 × 480	640 × 480	1280 × 1024	654 × 480
Brightness (peak pixel luminance in footlamberts)	200	100	N/A	24 (80 candelas/m^2)
Colors	4096	4096	16	4096
Viewing angle	±55 degrees horizontal, +15 degrees, −45 degrees vertical	±55 degrees	±40 degrees vertical, ±50 degrees horizontal	±20 degrees
Contrast ratio	60 to 1	60 to 1	40 to 1	25 to 1
Applications	Video displays, personal computers, workstations, TV, high brightness	Video displays, personal computers, workstations, TV	Video displays, personal computers, workstations, TV	Personal computers (not for TV)
Availability	Now	By 1995	By end of 1992	Now

offered by FPDs will increase demand for the technology.

FPDs are generally composed of two glass plates pressed together, with the active display elements located between the plates. Simple flat panels, on the order of watch displays, form images by electrically selecting image segments to form alphanumeric characters or icons.

High-resolution FPDs use a matrix-addressing scheme to electrically select pixels using transparent, conductive electrode stripes on the front sheet of glass and orthogonal electrode stripes on the back sheet of glass. The areas where the front and back orthogonal electrodes intersect define the pixels and their electrical addresses by row and column.

Simple-matrix, or passive-matrix, flat-panel control involves applying pixel data, or voltage, row by row. A row of pixels is lighted by applying a common voltage to the row electrode stripe while applying appropriate voltages to each pixel on the column electrode stripes to achieve the desired brightness of each pixel in the row. Thus, each row of pixels is lighted once per picture frame and then takes its place at the back of the queue and waits to get lighted again.

To provide the desired average brightness, passive-matrix displays depend on high pixel brightness during the short time the pixels are lighted. Images on passive-matrix displays usually flicker at the frame rate because the pixels are on for a fraction of the frame time. But the response of the human eye is slow enough to filter out most of this effect (see "Displays: The Human Factor" on page 195).

The active-matrix addressing method increases a display's brightness and eliminates display flicker by keeping pixels lighted most of the time. Active-matrix addressing uses an electronic switching device for each pixel controlled by the row electrode to gate voltage from the column electrode to the pixel. The capacitance of the pixel stores the voltage until it is refreshed or changed in the following frame. Functionally, the active-matrix panel is similar to a DRAM.

A 640- by 480-pixel monochrome VGA display uses 640 column electrode stripes and 480 row electrode stripes. Adding color to the display triples the number of pixel elements and electrode stripes, with red, green, and blue subpixels required for each pixel.

A full-color VGA display must have 921,600 picture elements and switching devices for active-matrix addressing. Every pixel must be functional, because the human eye can perceive minute defects in a displayed image. The size and complexity of FPDs, as well as the necessity for 100 percent pixel yield, present monumental problems in producing high-resolution FPDs that sell for reasonable prices.

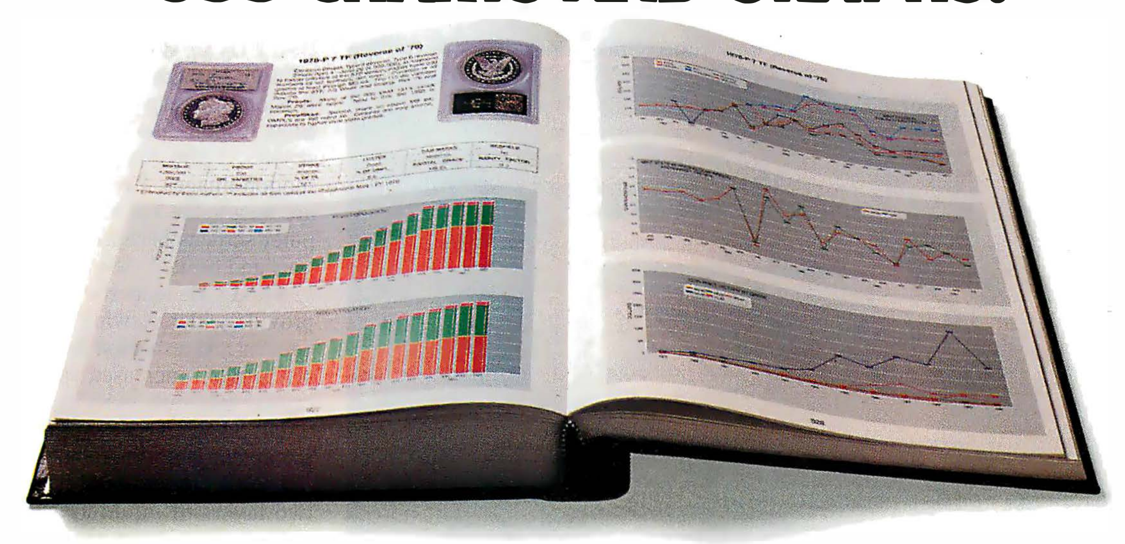
BYTE ACTION SUMMARY

The consensus is that the AMLCD is the heir apparent to the CRT. However, coming on strong are other types of displays that may well be more suited for your applications. ACPDPs, FEDs, and ACTFEL displays could find new markets and leap ahead of LCD technology.

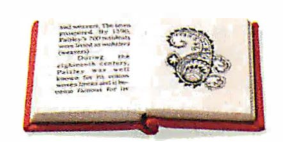
LCD Technology

LCDs use a liquid crystal—an oily substance containing rod-like molecules (cyanobiphenyls) that respond to electrical fields by reorienting themselves along electrical-field lines—to transmit or block the light used to create an image. The most

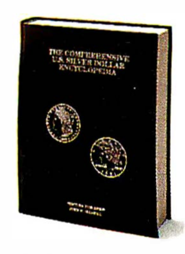
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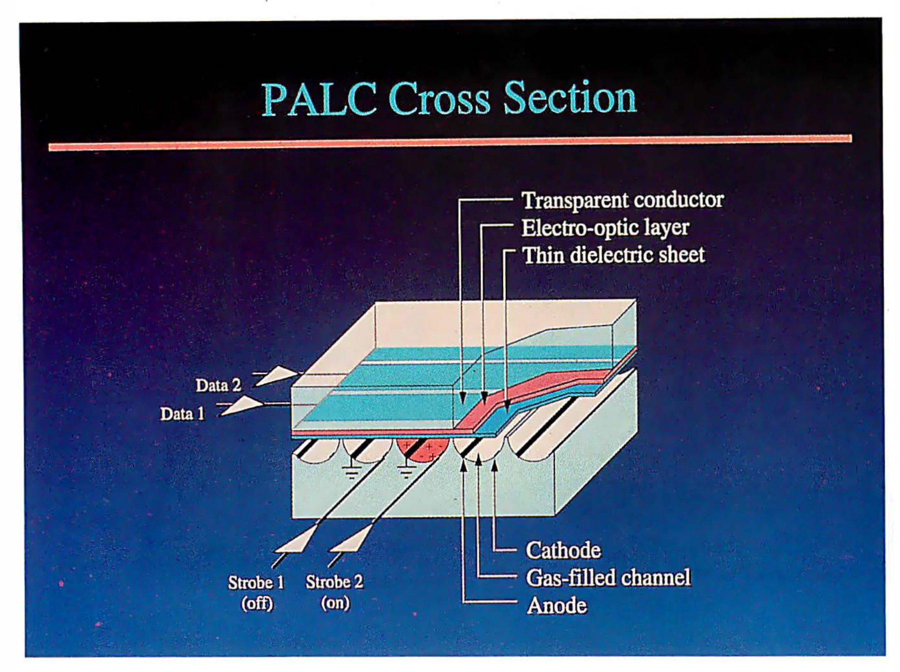
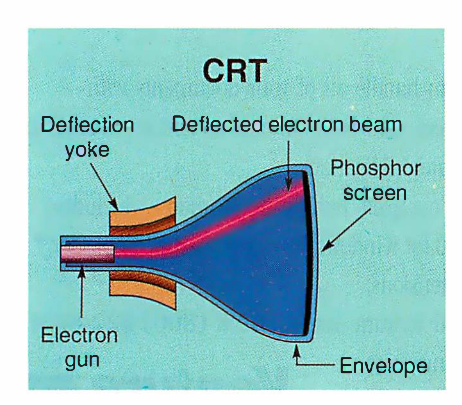


Photo 1: *The PALC display replaces the active-matrix TFTs with a simple gas-filled channel for each pixel row. Electrodes in the channel ionize the gas, which connects the pixels of the row to their respective picture data columns with a plasma switching action. When the plasma is extinguished, the low-leakage currents allow the pixel capacitances to hold the picture data for the duration of the frame. (Courtesy of Tektronix)*

prevalent FPDs are the 90-degree TNLCDs (twisted nematic field effect LCDs), such as those found in watches and handheld games. With no voltage (field) applied to a given pixel, the rod-like molecules, which are next to the electrodes on the glass substrate, are aligned at 0 degrees. They gradually rotate through the liquid-crystal film until they are at 90 degrees next to the opposite substrate.

Polarized light passing through the liquid crystal is rotated 90 degrees, allowing it to pass through a polarizing film on the other side. When pixel voltage is applied, liquid-crystal molecules align themselves perpendicularly to the panel. No polarity rotation takes place, and light is blocked by the polarizing film. The liquid crystal is sensitive to temperature, shock, and vibration—factors that must be addressed before LCDs can be considered for use in rugged environmental conditions.



The electron gun produces a beam that is directed by the deflection yoke and strikes the phosphor screen to produce light. CRT components are contained in an envelope that allows the whole process to take place in a vacuum.

LCDs that use ambient light require high ambient lighting for readability. The best way to view backlighted LCDs, however, is in low ambient light.

Full-color LCDs use red, green, and blue filters on the subpixels used to produce RGB colors. Filter losses and pixel-area losses in the pixel subdivision reduce the light transmitted to about 5 percent of the backlight illumination. To overcome the light loss, full-color LCDs require high-wattage backlighting.

Manufacturers are developing several types of FPDs, including PMLCDs (passive-matrix LCDs), AMLCDs (active-matrix LCDs), ACPDPs (AC plasma display panels), ACTFEL (AC thin-film electroluminescent) displays, FEDs (field-emission displays), VFDs (vacuum-fluorescent displays), and LEDs (see table 1). VFDs and LEDs are used for a great many applications, but manufacturers have not found significant uses for them in computers and businesses.

PMLCDs

PMLCDs are slow because the liquid crystal used in them requires 100 to 200 milliseconds to respond to the fields applied. Slow response time minimizes flicker but results in ghosting and blurring of fast-motion images. Passive-matrix TNLCDs are unsuitable for workstation and computer screens because of their poor contrast and limited viewing angle.

STNLCDs (supertwist nematic LCDs) provide wider viewing angles and better contrast and resolution than TNLCDs. *STN* refers to an increased amount of liquid-crystal molecule twist in the display material. STNLCDs are used extensively in laptop computers and other portables.

Double supertwist nematic LCDs use two layers of liquid crystal to improve contrast and viewing angle. The trade-off, however, is increased complexity, weight, and cost.

AMLCDs

Unlike PMLCDs, AMLCD pixels are energized all the time. This feature improves image brightness. AMLCDs, some believe, can achieve contrast ratios of up to 100 to 1. The active-matrix drive, usually made up of TFTs (thin-film transistors) or diodes, allows the use of faster-response liquid crystal, which can effectively display video images without blurring.

Because an active-matrix panel is essentially a giant IC with millions of TFT switches fabricated onto a glass plate, its manufacturing process is similar to IC fabrication on silicon wafers. But displays are much larger than wafers, making manufacturing more difficult and yields lower. Yields for small AMLCDs are beginning to exceed 50 percent; however, yields for larger sizes are still low—thought by some in the industry to be within the 10 percent range.

Manufacturers use complex TFT redundancy, test, and repair strategies to salvage faulty active-matrix panels. They repair faulty row and column interconnections and replace faulty TFTs with redundant TFTs. It's expected that AMLCD manufacturing technology will mature over the next few years, with resultant major price reductions.

Meanwhile, AMLCD product prices are quite high (in the $1000 to $2000 range). To make matters worse for Japanese manufacturers, in 1991 the ITC (International Trade Commission) levied a 63 percent duty on the importation of Japanese products into the U.S. The ITC ruled in favor of the Advanced Display Manufacturers of

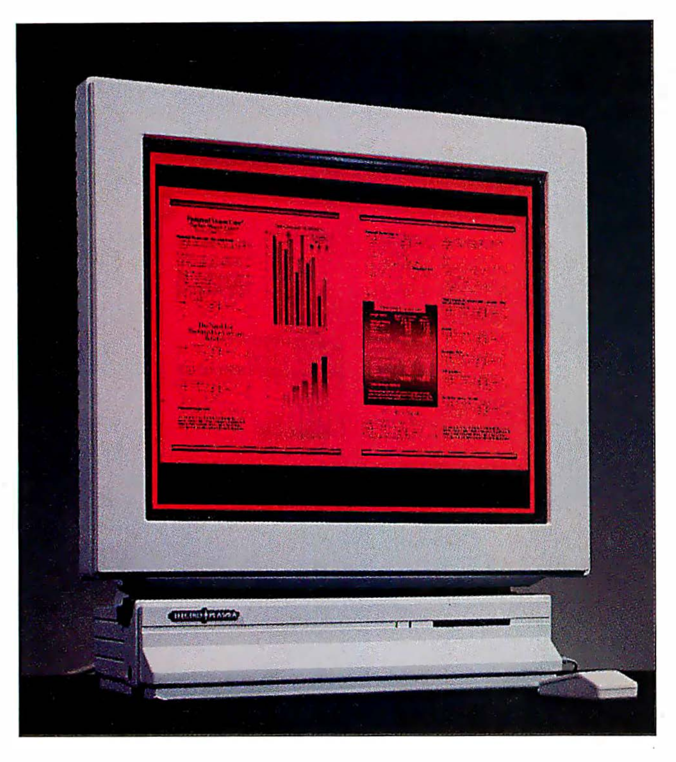


Photo 2: *ACPDPs are produced in a wide range of sizes. They are bright, have good resolution, and come in thin packages. Small ACPDPs work well in instrumentation and portable computers. Large ACPDPs can display a lot of information at one time, which makes them good for use in computer terminals, CAD displays, and command-and-control applications. (Courtesy of Electro Plasma)*

America, which claimed that to capture the U.S. market the Japanese were selling their panels for less than what it cost to produce them.

OIS (Optical Imaging Systems, Troy, MI) is gearing up for higher-volume production of AMLCDs with a no-duty price advantage. In July 1991, Canon (Hiratsuka City, Japan) announced that it would begin producing a full-color 10-inch diagonal AMLCD by the end of the year (the status is unknown), with a price objective of $350 per display by 1995. A $350 to $400 price range appears to be a common objective among FPD manufacturers.

FLCDs

Unlike the liquid crystal used in TNLCDs and STNLCDs, the material in FLCDs (ferroelectric LCDs) is bistable: When an electric field is applied to it and then removed, ferroelectric liquid crystal holds the electrical charge, much like ferrous materials hold magnetic fields after an applied magnetic field is removed. This hysteresis can be used to store pixel-drive voltages, replacing the complicated, low-yield TFT active-matrix arrays. Bright, flicker-free FLCD performance is comparable to that of TFT LCDs. The response time of ferroelectric liquid crystal is about 100 nanoseconds, a feature that makes FLCDs especially well suited for video displays.

FLCD construction is much the same as that of other LCDs, but the gap between the glass plates must be between 1 and 2 microns instead of between 5 and 7 microns. This spacing is difficult to achieve and maintain uniformly over large display areas.

Liquid-crystal molecule alignment is more difficult in the thinner layers, and misalignments cause optical zigzag effects. FLCD-drive waveforms are complicated because they require that voltage reversals erase old data before any new data is stored. Furthermore, gray scale is hard to achieve because of the FLCD's bistable nature.

Canon claims it has resolved FLCD fabrication problems. In October 1991 at the Japan Data Show, Canon showed off an impressive 960- by 1312-pixel, 15-inch monochrome FLCD and a pair of 1280- by 1024-pixel, 15-inch color FLCDs. The company will use the monochrome display internally on a Japanese-language desktop publishing system.

PALC FPDs

Tektronix (Beaverton, OR) has developed the PALC (plasma-addressed liquid crystal) display, an emerging AMLCD technology. The plasma active-matrix panel functions like the TFT array, but with simpler, potentially higher-yield structures—channels containing an inert gas. Under the trade name Tekvision, the PALC concept has been developed and supported in part by the Defense Advanced Research Projects Agency. (See photo 1.)

The PALC active-matrix approach eliminates the need for TFTs, replacing them with ionized gas to connect each pixel to its data line for application of the control voltage. Data-switching times are a short 5 microseconds per row, a speed that allows 30-Hz frame rates for large, high-resolution panels. The voltage is held by the pixel-electrode capacitance until the voltage is updated in the following frame. Leakage currents, prevalent in TFTs, are virtually nonexistent in PALC displays, resulting in a reduction of the voltage decay to a negligible value.

ACPDPs

ACPDPs produce light by ionizing a low-pressure inert gas, a technique that yields a glowing discharge similar to that of neon signs (see photo 2). When sufficient voltage is applied between a pixel's row and column electrodes, the gas achieves the *plasma state* and discharges the characteristic monochromatic amber-orange color.

Unlike in other display technologies, once a pixel is illuminated in an ACPDP, it remains so until extinguished. This feature results in the creation of a display panel with "inherent memory"; it is bright and flicker-free without the complexity of active-matrix pixel drivers.

ACPDP electrodes form a high-capacitance load for the display-driver circuits, which would result in high power consumption if it were not for power-recovery circuits. These circuits save the energy stored in the capacitance in each AC cycle and use it in subsequent cycles. Thus, ACPDPs are as energy efficient as other types of displays.

The ACPDP's lack of refresh lends itself to large displays. Photonics Systems (Northwood, OH) offers a 60-inch diagonal ACPDP. Large displays like these can provide real-size images for CAD/CAM and desktop publishing applications without shrinking, approximating, or clipping the image.

ACPDPs have fast response times with update rates of from 25 to 60 frames per second. They have bright, high-contrast, flicker-free images with wide viewing angles. ACPDPs are reliable, long-lived, and rugged. (See table 2.)

The disadvantages of ACPDPs include high cost, no gray scale, and no color. The advent of high-volume production should reduce the costs of this simple manufacturing process. Photonics Systems offers an ACPDP with gray scale, and other manufacturers are also developing color ACPDPs.

Electro Plasma (Millbury, OH), Photonics Systems, Plasmaco (Highland, NY), and other manufacturers offer displays

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The Electronic Whiteboard

RICHARD BRUCE AND SCOTT ELROD

If you've ever tried to work on your favorite computer application with several people who are not familiar with computers, you may have gotten pretty frustrated. Soon there will be a way for you to easily interact electronically with these colleagues.

Among the problems facing the computer industry are two issues relating to the importance of displays. First, most computers communicate through small displays that are about the right size for one person to use. This display size makes it tough for several people to work simultaneously on the same machine. Second, most people don't type and, consequently, don't use computers—especially if someone is looking on as they are trying to work up the nerve to start hunting and pecking on the keyboard.

People at Xerox PARC (Palo Alto Research Center) have come up with a solution to these problems: a computerized whiteboard (see photo A). It has a display large enough to permit many people to view it simultaneously from anywhere in the room and a stylus input that lets you write directly on the board. Combine a board like this with an interface that makes operating the board as simple and intuitive as writing on a whiteboard, and, bingo, everyone can play.

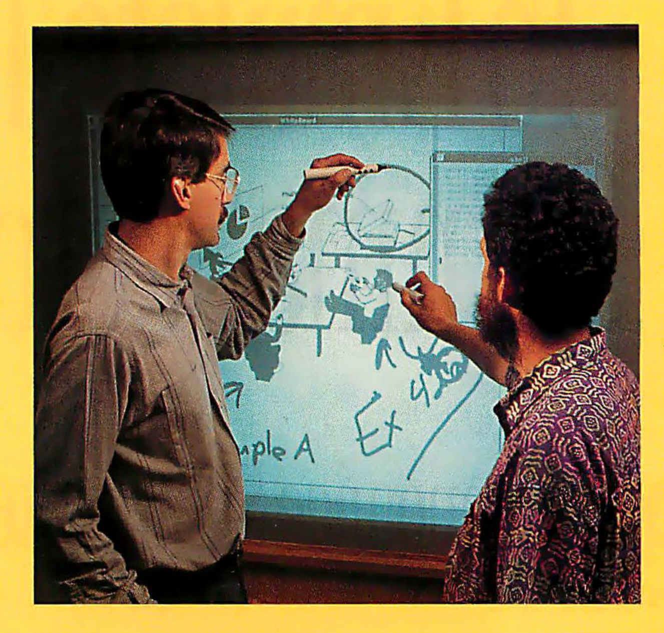


Photo A: *This Xerox PARC computerized whiteboard uses a projected LCD and a stylus technology that were developed for this application. Several of these systems are connected to the Xerox network.*

A Whiteboard's Bells and Whistles

You can do a lot more with a computerized whiteboard than you can with the typical whiteboard that hangs on many office and factory walls. You can connect a computerized whiteboard to a network, so you can output what you write on the board to a printer or a storage device. Later, you can instantaneously pull up the stored data onto the board.

In addition, you can scan a document into the board. In collaboration with your friends, you can mark up the document and save or print out an annotated version. Thus, you can create a document in your office and retrieve it later on a computerized whiteboard for use in a meeting or presentation.

Another application involves connecting a number of computerized whiteboards over a telephone line to create a surface shared by several remote sites. A mark you make on one board will appear on the other connected boards. At sites without computerized boards, your colleagues can follow your meeting by connecting their personal computers to the shared surface.

Workers who are in the field can fax documents to such a board. With modern compression technology, common telephone lines offer sufficient bandwidth to accommodate this kind of shared application. You can see how this capability will enhance teleconferencing.

At Xerox PARC, we see a number of important application-dependent requirements for this type of display. For group use as a collaborative tool, we believe that a moderate resolution of around 40 lines per inch is adequate for working close to the board and for displaying material to people in a meeting room some distance away.

The aspect ratio is of particular importance. Rather than a 4-to-3 ratio, which is standard for displays and TVs, the 16-to-9 ratio proposed for HDTV would be more useful. The broader aspect ratio reduces the height of a display and increases its width, a feature that would benefit both tall and short users by providing more usable surface area.

Importance of Image Quality

For a shared board, color is important because it highlights the information and differentiates between the input of users at various sites. Although you don't need many gray levels for writing on a board, you need at least 64 levels of gray to recognize a video image in a window or on the entire screen. Having more gray levels would improve the image quality sufficiently to let you watch your favorite videos in your leisure time.

Cost-effective large displays are projected from either CRTs or LCDs. A CRT-projected image looks good from a distance, but if you stand next to the screen, you can see the image quiver. This phenomenon is caused by variations in the position of the electron beam that is focused on the phosphors. An LCD image, however, is steady even when you look at it close up. Consequently, this type of image is more acceptable for electronic-whiteboard applications.

There are two kinds of LCDs on the market: passive-matrix devices (e.g., the supertwist displays on most laptops) and active-matrix devices. Although the passive-matrix displays are less expensive and brighter, they have slower response times and cannot support video. The active-matrix displays have adequate response times for video and tend to have more saturated colors because of higher intrinsic contrast. However, these displays are more expensive and project darker images than the passive LCDs.

Brightness is important to the quality of an electronic whiteboard because it may have to compete with ambient light from indoor lighting or a window. CRTs will have real problems supplying sufficient brightness. As a result, the solution will come from an LCD technology or something new. Because the home large-screen TV market is driving this technology, you can be assured that interesting solutions are not far away.

Richard Bruce manages the hardware systems area at Xerox PARC (Palo Alto, CA). He has been working with LCD technology and stylus-input technology for the past four years. Scott Elrod is a member of the research staff at Xerox PARC. He has developed new printing and display-input technology and has been the systems designer for Xerox's computerized whiteboard. You can contact them on BIX c/o "editors."

with an extensive range of pixel resolutions and panel sizes for various applications. ACPDPs have been interfaced to many computer platforms—including PCs, Sun systems, Macs, and X Window System machines—as well as used as ANSI terminals. For over 10 years, ACPDPs have been widely used in military, medical, and industrial applications.

In one to five years, ACPDP products will include full color. Photonics Systems has already demonstrated a workstation-size ACPDP color monitor that compares well to CRT monitors. On the inside of their viewing screen, color ACPDPs use RGB phosphors that are activated by ultraviolet light (photoluminescence) from the plasma glow. Fluorescent lights use this efficient process.

ACTFEL Displays

ACTFEL displays emit light produced by electron excitation of phosphors. The common rectangular plug-in night-lights are ACTFEL devices. ACTFEL displays are solid-state devices fabricated with thin-film deposits on one sheet of glass with a second sheet of glass acting as a protective cover.

The thin-film luminescent layer is sandwiched between transparent dielectric layers and the usual matrix of row and column electrodes. An ACTFEL display is a capacitive device, with the phosphors being activated by the displacement current. You can increase luminance by increasing the AC drive frequency or the capacitance. These high-capacitance devices become low-power displays suitable for portable applications when power-recovery circuits are used.

Monochrome and two-color ACTFEL displays are available, and manufacturers are developing full-color versions. Color-display brightness is determined by the weakest color for proper RGB balance. Developers must produce a bright-blue phosphor to implement a full-color ACTFEL display.

ACTFEL display fabrication uses deposition processes long used for IC chip fabrication. These processes, when scaled up to handle the larger display panels, lend themselves to automation and large-volume, low-cost production.

Planar Systems (Beaverton, OR) and Sharp of Japan (Nara, Japan) are the two major producers of ACTFEL displays. ACTFEL display manufacturers produce monochrome displays for all standard display formats in sizes up to 18 inches diagonal. ACTFEL displays offer excellent brightness at low power (no backlighting is required) and crisp high-resolution images.

FEDs

Flat-panel FEDs have recently received considerable attention in the technical and business press. Much of the renewed interest in this old technology is due to the efforts of Leti CEA (Grenoble, France), a government laboratory. The French research facility has produced and shown operational 6-inch monochrome FEDs and a 6-inch RGB color-panel demonstration device.

The excitement about FEDs stems from their similarity to CRTs. A FED is essentially a flat CRT, but with a difference: A FED has an electron gun for every pixel. A CRT has one gun shared by all its pixels. Electron-beam impingement on each FED pixel's phosphor dot is continuous; a CRT beam scans each phosphor dot only once per frame.

FEDs offer the potential for producing in a thin flat panel very bright, low-power, high-resolution displays with the same screen appearance as CRTs have. Additionally, FEDs produce insignificant x-ray emissions and no potentially hazardous magnetic fields.

Numerous research labs and companies are developing FED technology. Among them is MCC (Microelectronics and Computer Technology, Austin, TX), which is seeking sponsors to underwrite a vertically integrated FED consortium project to speed the commercialization of this technology.

Large-Area HDTV, Anyone?

Large-area displays, such as those required for HDTV, present monumental scale-up problems for display technologies. A CRT for a 3- by 5-foot HDTV screen would be heavy and deep (about 5 feet). Even if you were able to buy a CRT-based HDTV, it would not fit through the doors of your house.

The FPD technology for HDTV must involve manufacturing processes that are simple, low-cost, and scalable with high yields to the large areas that are required (see "HDTV Is Coming to Desktop" on page 189). ACPDPs, already produced in large sizes, may become an attractive choice for HDTV FPDs. FLCDs and FEDs, as well as ACTFEL and PALC displays, are other possibilities.

Another approach to large-area display screens is called *tiling*. This technique fits small high-yield FPDs together (like floor tiles) to make a larger screen. In view of the low manufacturing yields expected for large FPDs, tiling small high-yield panels together makes economic sense. Magnascreen (Pittsburgh, PA) is one company that is exploring this particular approach. The major problem associated with tiling

REPRESENTATIVE ACPDP AND ACEL DISPLAY PERFORMANCE

Table 2: *These emissive displays are suitable for rugged environments and come in a wide range of sizes (up to 60 inches in plasma). They have fast response times, high contrast, bright images, and wide viewing angles, and they are power-efficient. Monochrome and two-color models are available, and full-color is under development. Photonics Systems has demonstrated an impressive ACPDP full-color workstation monitor, slated to be available late this year.*

	Display type			
	Planar ACTFEL	**Photonic Systems ACPDP**	**Plasmaco ACPDP**	**Electro Plasma ACPDP**
Diagonal size (inches)	10	20–30	21 3/10	23
Required power (W)	12	60	32	N/A
Resolution (pixels)	640 × 480	1024 × 1024	1280 × 1080	1280 × 1024
Brightness (peak pixel luminance in footlamberts)	35	Greater than 75	40	45
Colors	Monochrome	Monochrome	Monochrome	Monochrome
Viewing angle (degrees)	Greater than 160	160	160	160
Contrast ratio	Greater than 100 to 1	Greater than 50 to 1	50 to 1	Greater than 50 to 1
Applications	Video displays, workstations	Video displays, workstations	Video displays, workstations	Video displays, workstations
Availability	Now	Now	Now	Now
Other		Touch-entry, 64-level gray scale		Touch-entry

is that the human eye can discern errors in panel joints of less than 1 pixel in size when the panels are improperly fitted together.

Recently, manufacturers have used three monochrome AMLCD panels with respective red, green, and blue filters; a powerful backlight; and a projection lens to produce large full-color projected images. This approach is similar to the familiar technique of combining the images of three CRTs (see "Monochrome to Color" on page 179).

The possibility of using projection displays for large-area displays is intriguing because small high-resolution LCD panels are less expensive than large ones. A problem results, however, from the considerable amount of space a projector beam consumes.

One solution is to fold the light path into a few inches of space behind the rear projection screen. The dilemma this technique creates is how to avoid or correct the image distortions and luminance nonuniformities produced by folding the beam. Projectavision (New York, NY) is addressing this issue.

Looking Past CRTs

CRTs will dominate the display market until FPD image quality becomes superior to that of CRTs and FPD prices become competitive with CRT technology. In addition, there are other display technologies, such as three-dimensional (see "3-D Displays," May BYTE) and stroboscopic displays, that are being used for applications such as medical imaging and military and commercial aircraft command and control.

Passive-matrix LCDs will lead the flat-panel pack for most applications not requiring fast response. In applications that require fast response time, people may come to use AMLCDs, FLCDs, ACTFEL displays, or ACPDPs.

Clearly, the most popular FPD is the AMLCD using TFTs. The Japanese industry is solidly behind this technology, and demand greatly exceeds production capabilities. LCDs may win out in the marketplace because the multibillion dollar investments in R&D and manufacturing should rapidly mature the technology and drive down production costs. However, AMLCDs continue to have manufacturing problems, and this could afford other displays an opportunity to leap ahead of AMLCDs by providing better performance at a lower cost.

FLCDs and PALC displays are potentially successful LCD technologies. Other candidates include FEDs, ACPDPs, and ACTFEL displays, with features such as wide viewing angles, high brightness, crisp images, and low power consumption. With their already-demonstrated full-color capabilities, however, ACPDPs and ACTFEL displays will have to be produced at competitive prices.

Both the CRT and the FPD markets will continue to expand. The market-research firm Stanford Resources (San Jose, CA) predicts that the CRT market will experience a 9 percent compound annual growth, advancing from a volume of $11.6 billion in 1991 to a volume of $19 billion in 1997. It also forecasts that FPDs, which in 1991 had a $4.6 billion market share, will command a $7.3 billion share of the market by 1995.

Last year, nine U.S. display manufacturers (Cherry, Planar Systems, Plasmaco, Electro Plasma, OIS, Photonics Systems, Standish, Tektronix, and Magnascreen) formed the ADC (American Display Consortium) to do precompetitive research. ADC companies offer all major display technologies. This kind of collaborative effort—leveraging resources and building partnerships—is an essential strategy for success in this highly competitive market. ■

Ollie C. Woodard Sr. is a consultant whose work focuses on displays and electron-beam technology. Previously, he was the manager of MCC's Display Technology Project. Tom Long is director of the ADC, which is affiliated with the MCC High-Value Electronics Program. Prior to joining MCC, Long was vice president of Tektronix Laboratories. You can reach them on BIX c/o "editors."

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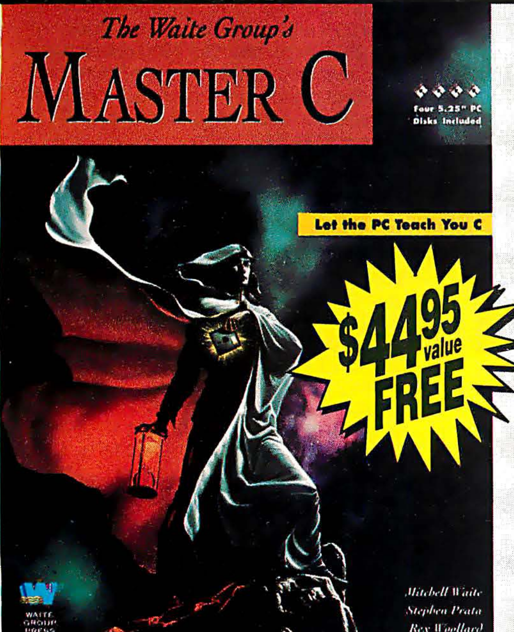
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About Displays

Resolution is usually described in terms of pixels (e.g., 640 by 480 pixels for VGA, 1024 by 768 pixels for Super VGA, and 1152 by 882 pixels on some Macs), but it's really not that simple, as I'll explain later. Beyond resolution, most monitor advertisements specify the screen size, dot pitch, and number of colors or gray levels. But two important properties—contrast and brightness—are hardly ever mentioned. All these factors contribute to the bottom line: the sharpness and clarity of fine lines in text and drawings and the attractiveness and effectiveness of shaded or colored images.

The VGA color monitor is probably the most common display today. If you read the specifications for it, you expect the monitor to produce approximately 640 pixels on each of the 480 rows. There is a good chance, however, that it won't do that. A monochrome display is more likely to show 640 pixels per row than a color

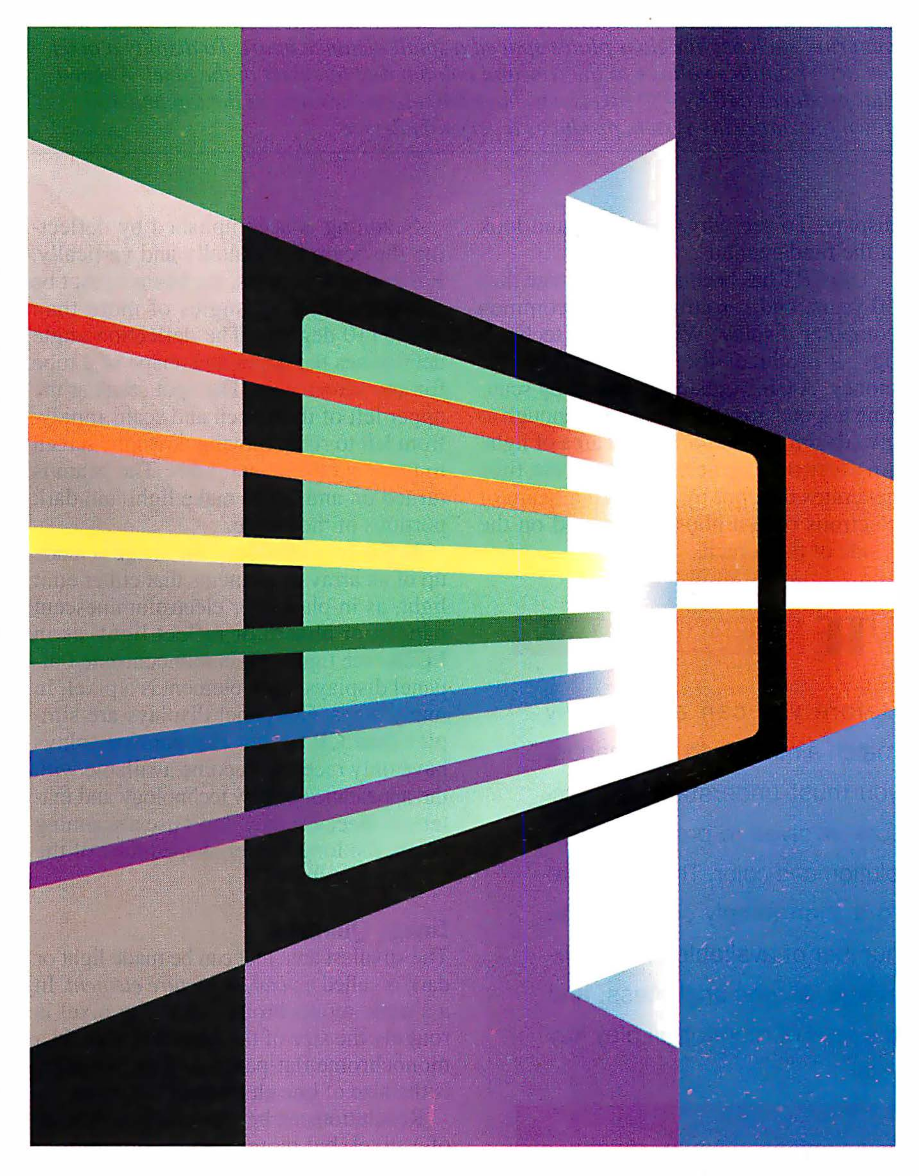


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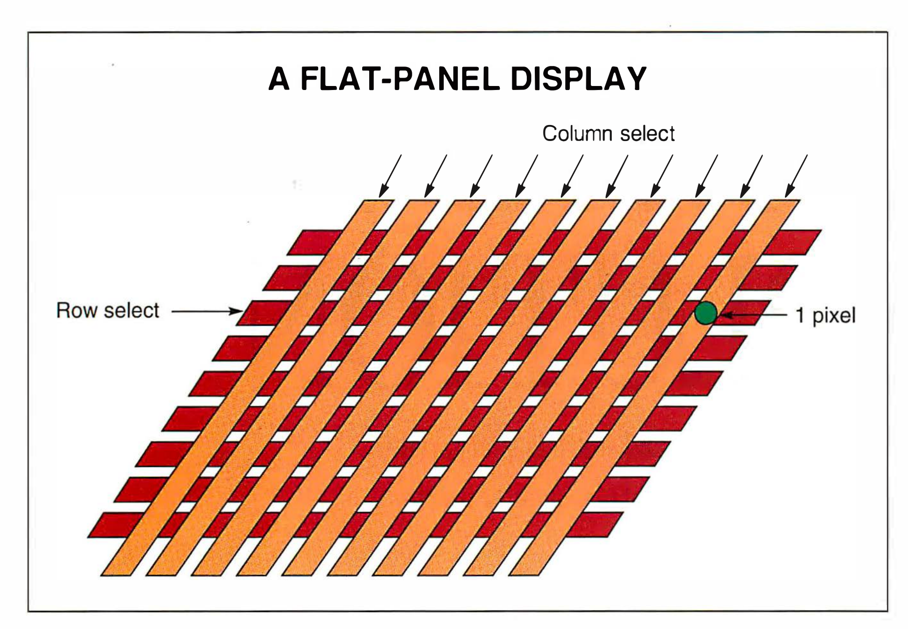


Figure 1: *A flat-panel display has two sets of electrodes deposited on transparent material, such as thin glass plates spaced a small distance apart. To display a pixel, the driver applies voltage to the row and column that intersect at the pixel. A panel that produces 640 by 480 pixels will have 640 electrodes across the top and 480 down the side. This system produces a very thin device.*

display. To see why, step back and look at the fundamentals.

The CRT has been around for more than 60 years, and it's still the most common computer display. With today's technology, it produces the best image for the money. A CRT creates an image by scanning a spot across the screen fast enough to give the impression of a filled area of light. An electron gun at the back of the tube generates the spot by focusing a beam of electrons onto a phosphor coated on the inside of the screen.

BYTE ACTION SUMMARY

Before you can adequately match a monitor to your needs, you must understand the factors involved in producing resolution and color. There is more to it than simply counting the number of available pixels. Pixel size, screen brightness, and the type of monitor all play key roles.

Scanning is accomplished by deflecting the beam horizontally and vertically. For practical reasons, the beam cannot be deflected through angles of more than about 110 degrees. The deflection angle determines the depth and shape of a tube for any screen size. The spot starts at the upper left of the screen and scans rapidly from left to right, moving down the screen to trace out horizontal lines. The beam is turned on and off to make light and dark portions of the image.

In flat-panel displays, the image is made up of an array of elements that either emit light, as in plasma or electroluminescent panels, or absorb or reflect light, as in LCDs (see figure 1). In monochrome flat-panel displays, each element is a pixel. In many ways, flat-panel displays are simpler than CRTs, but flat-panel displays have only recently become available with the appearance of new technology and materials. Because they don't use a scanning beam, the long funnel-shaped tube of the CRT is eliminated.

Image Qualities

The smallest area that can be made light or dark is called a *pixel*, or *picture element*. In a simple monochrome CRT, the pixel is roughly the size of the scanning spot. In a monochrome flat-panel display, the pixel is the size of one element of the array.

Resolution can be expressed as the size of 1 pixel, but more often, it's expressed either as the number of pixels or dots per inch or as the total number of pixels. The higher the resolution, the smaller the scanning spot or display element. In a CRT, high resolution is difficult to achieve because it's hard to make a very small spot (particularly while maintaining its brightness) and to turn the spot on and off rapidly enough to produce a sharp image while the spot is scanning.

In a flat-panel display, high resolution is difficult to achieve because of the large number of elements needed to create the image. The chance of producing a bad element during manufacturing increases with the number of elements required, and a bad element will produce a defect in the image, reducing manufacturing yield and increasing cost.

The resolution of a flat-panel display is determined by its geometry—it has just so many pixels. But a CRT doesn't have a specific number of pixels. The pixels gradually merge as the tube is called on to produce more and more pixels across the screen, because the spot is too large or the electronics won't modulate the spot fast enough. When a resolution is stated in a CRT's description, it represents the number of pixels that can be shown with a certain degree of clarity.

In the simplest monochrome CRT, one scanning spot is turned on or off, producing a two-level image. Because it is simple, it offers the highest resolution and contrast at the lowest cost. If your display requirements are mainly for text and line drawings, you should consider that kind of "old-fashioned" monitor.

To produce gray levels in a CRT, an analog signal varies the current in the scanning electron beam. The signal is generated by creating a serial data stream from the computer's bit-mapped image and passing the data stream through a DAC (D/A converter). Thus, to display 256 gray levels, the CRT must have an 8-bit-deep memory and an 8-bit DAC operating at 15 MHz or more. That adds complexity and cost to the simpler two-level display.

Gray levels in flat-panel displays are controlled in several ways. In LCDs, analog voltage is applied to the elements to control the amount of light they transmit or reflect. In plasma panels, a pixel is either on or off, as in a two-level display, but the brightness is controlled by varying the *duty-cycle*, or the length of time the pixel is on.

More circuitry is needed to control a gray level in a flat-panel display than in a CRT, so flat-panel displays are limited to fewer gray levels. Furthermore, in an LCD, the gray level varies with the viewing angle, so the appearance of a gray-level

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Squeezing Out More Gray Levels

CHRISTOPHER W. TYLER

If your gray-scale images look more like contour maps than smoothly gradated images, you've run across a basic limitation of standard displays: The human eye can resolve gray steps with an accuracy of about 0.2 percent, a capability much finer than the gray-level precision of 8-bit monitors (which is about 1.5 percent when phosphor nonlinearities are taken into account). To allow people to study the limits of visual detection on inexpensive equipment, I developed a technique that lets you achieve the required gray-level precision by having appropriate control of a color monitor.

A typical color display has three color guns, each with 8 bits of luminance variation. Normally, luminance and color are computed independently: The color is specified by two ratios between the three guns, and the luminance is set by the sum of the three levels. Thus, a 24-bit color display with 8 bits per gun has only 256 possible levels of luminance at a constant color ratio, even though it can present more than 16 million color-luminance combinations.

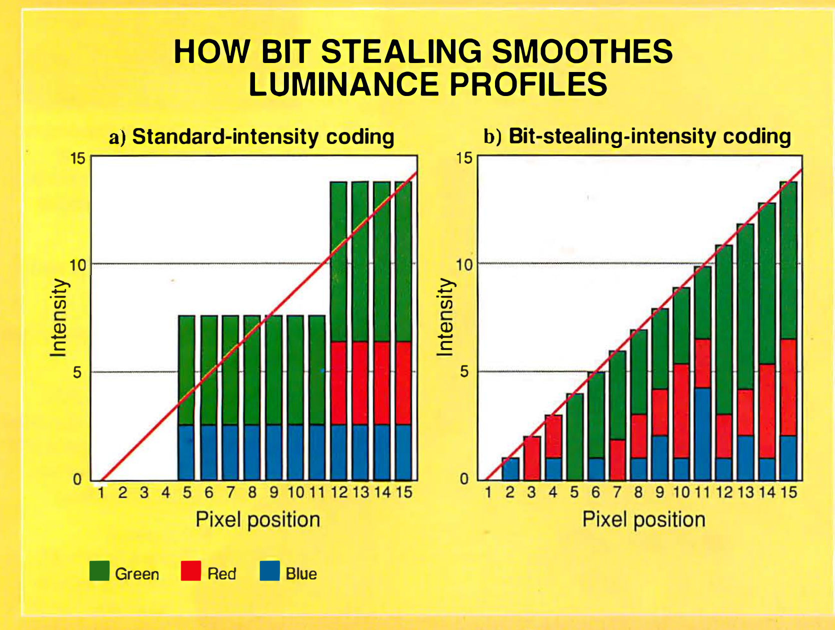


Figure A: (a) *Steps obtained when a system with fixed color ratios attempts to depict a luminance ramp.* **(b)** *When each RGB value is allowed to jitter by one level from those of its companions, the summed value representing the net luminance output increases steadily in steps of ⅐ the fixed-color increments. For simplicity, luminances are assumed to be linearly related to the step values.*

An Artful Dodge

To get greater gray-level precision, I "steal" bits from the color variation to increase the precision of the luminance variation in each pixel. The technique can provide thousands of gray levels at a cost of 1 bit of color jitter, the undetectable color variation caused by using small nonfixed color ratios. This idea is similar to the spatial dither techniques commonly used to enhance gray scale, except that bit stealing operates in a single pixel.

Bit stealing is ideal for presenting gray-scale images encoded to high precision (e.g., 12 to 36 bits) on an inexpensive 8- to 24-bit color display. You can use the method to enhance gray-scale displays of any bit resolution, but I'll focus on 8- to 24-bit displays. You can further elaborate the method to full-color displays by optimizing the effective ratio of luminance bits to color bits according to the detection characteristics of the human eye.

To get a smoother luminance profile, you select each gun individually within the range of each luminance step (see figure A). If the luminances of the three color guns are in the ratio of 1 to 2 to 4, a binary sequence of steps on the three guns provides seven steps of luminance information for every step available in a fixed color-ratio scheme. This approach provides a luminance

image changes with the viewer's position. Of course, many users are willing to accept these restrictions so that they can have the compactness and lighter weight of a flat-panel display. And improvements are coming quickly.

How Color Is Produced

In most displays, color is produced with patterns of three dots or stripes in the primary colors (i.e., red, green, and blue) on the screen. The *dot pitch*, or simply the *pitch*, is the distance separating the dots or the stripes (see figure 2). A pixel is composed of neighboring dots that produce a color when the light mixes in your eye.

If you look at a color display closely (perhaps with a magnifying glass), you will see the colored dots. There are various criteria for determining how many dots are required to make 1 pixel of a color on a screen. For now, assume that it's three, one of each primary color. That puts another limitation on resolution. A pixel cannot be smaller than the dot pitch, the scanning spot in a CRT, or the element of a flat-panel display.

In a color CRT, there is another limit on resolution. Three electron beams scan across the screen to light up the RGB dots.

EFFECTIVENESS OF BIT-STEALING IMPLEMENTATIONS

Adjusted bit stealing is the monitor-adjusted method with single levels (see figure A). Compensated bit stealing is direct compensation without monitor adjustment, where red to green to blue = 2 to 6.5 to 1 and the bit-stealing values may vary by two levels. You cannot derive the luminance precision values in each row directly from those in other rows. Luminance levels give the number of levels available for the color palette under each method, expressed in the next two rows in bits and in percent precision for the D/A registers. Actual precision shows the percent precision of the display output at half-maximum luminance after considering phosphor nonlinearities, also expressed in bits in the effective bits row.

Method	Standard 8-bit	Adjusted bit stealing	Compensated bit stealing
Luminance levels	256	1786	3316
D/A bits	8	10.8	11.7
D/A precision	1/256	1/1786	1/4845
Actual precision (percent)	1.34	0.19	0.07
Effective bits	7.2	10.0	11.5

table with 7 × 255 + 1 = 1786 levels (10.8 bits), or almost seven times the normal luminance precision.

Back to Reality

Because the phosphor outputs of monitors are not linear, you must construct a table of the 1786 luminance entries from a calibration of the individual phosphor outputs to execute a practical bit-stealing implementation. You can use the table in reverse to go from the luminance level desired for a given pixel to the required RGB values for the D/A output.

The phosphor nonlinearities also limit the luminance precision that you can achieve. The D/A position for half the maximum luminance, for example, is 166 out of 256, where the effective luminance precision is reduced by 42 percent for any of the methods. The table compares the schematic and actual luminance precision obtained for two different bit-stealing methods with that of the standard output (see above).

The table indicates some of the improvements you can get with bit stealing, although you can develop different versions depending on the display application. The effective luminance precision available after phosphor nonlinearities increases from the standard 7.2 bits to 11.5 bits for a direct-compensation scheme. This is enough precision to banish sampling edges from visibility under the most demanding conditions.

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These beams are adjusted to converge on dots that are next to each other. If the adjustment is incorrect, the beams are misconverged, and the dot of one color may be misplaced a dot pitch or so from the others. Misconvergence produces colored edges, or smears, and it is most evident when you are looking at white text in the corners of CRT screens. Convergence can be adjusted, but it's also limited by monitor design (e.g., a black-and-white monitor doesn't have a convergence problem).

It is about three times more difficult to build a color display than it is to build a monochrome display, because color displays require at least three dots or stripes to make each white pixel and nearly three times the electronics to drive the display. To avoid using three times the memory, the number of gray levels in each color is usually restricted.

If each primary color is displayed with 256 levels, the monitor produces a whopping 16 million colors and requires 24 bits per pixel. Most applications do not need that. To work with a single 8-bit-deep memory, displays sometimes provide 3 bits (or eight levels) of red, 3 bits of green, and 2 bits (or four levels) of blue, for a total of 256 colors. That produces contouring in natural scenes, but it's enough colors for a lot of artwork, for color-coding complicated screens, and for visually engaging games.

Consider a 14-inch VGA display. The dimension represents a diagonal measurement of the image area, but it can also refer to a tube or panel diagonal, so an image might be smaller. For now, assume you have the full 14-inch diagonal viewing area. An image will have dimensions of 11⅕ by 8⅖ inches. To have 640 pixels across the screen, the pixel size must be 0.018 inch (i.e., 11⅕ inches/640), or 0.44 millimeter. A spot in a CRT or an element in a flat-panel display has to be smaller than that, and a dot pitch in a color display must be even smaller. If they aren't the proper size, the display won't have the resolution you expect. Sometimes a problem crops up.

The specifications of many displays refer to *addressability*: the number of pixel locations on the screen that the driver electronics can address. But being able to address pixel locations does not guarantee that the display will have the resolution to show all the pixels separately. If the scanning spot or dot pitch is too large, the electronics might address a location 1/640 the distance across the screen, but the light from two locations will blur together or, even worse, be the wrong color. Some value is inherent in high addressability (e.g., reducing jaggies on sloping lines), but don't assume that you can produce the expected number of pixels.

In a Super VGA display with 1024- by 768-pixel resolution, the dot pitch and scanning-spot size must be no greater than 0.28 mm for the same 11⅕-inch screen. In comparison, a typical 25-inch TV receiver has a dot pitch of about 0.70 mm. Did you ever try to read 10-point type on a TV set?

Resolution is more complicated than just the number of pixels in an image. Can an observer see those pixels? One display may produce bold, clear pixels; another may produce pixels that are faint and barely distinguishable. If the number of pixels is the same in both displays, you could say the resolution is the same, but one display will look better than the other.

A fuller description of resolution would

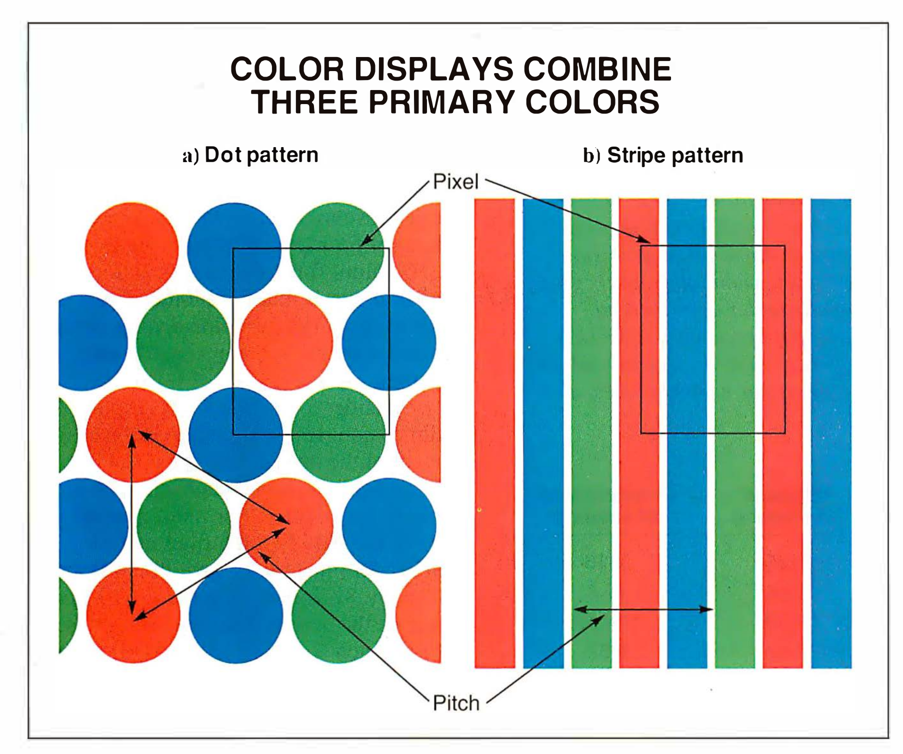


Figure 2: *Color displays, both CRTs and flat-panel displays, form colors by mixing three colored dots or stripes, usually red, green, and blue. One arrangement* **(a)** *uses a pattern of dots, and another* **(b)** *uses a series of stripes. The spacing between the dots or the stripes is called the pitch. A single white pixel must include the light of all three colors and must not change color as it moves across the screen.*

include the contrast afforded by a given number of pixels, but that level of technical information is rarely given for even high-performance displays. The contrast between adjacent black and white pixels is important because the strokes that often make up typical text are just 1 pixel wide. The eye's ability to resolve details decreases as the contrast and brightness of an image decline. Thus, contrast and brightness are important when you are looking at fine detail on a screen, including most text.

Unfortunately, as a CRT is made larger or a scanning spot is made smaller, brightness tends to decrease. Techniques that increase brightness, however, usually reduce contrast, so the designer must accept a compromise.

TV receivers are brighter than computer displays, but they have lower resolution. Developers are seeking ways of producing large CRTs that provide bright images with high contrast and high resolution. Even more engineering is going into the development of flat-panel displays. In large sizes, they have an advantage over CRTs because their brightness is independent of their size. Thus, for equal complexity of the display, and therefore at about the same cost, a two-level display has the best resolution, a gray-scale display has worse, and a color display has the worst.

The important combination of resolution and contrast is more completely described by the MTF (modulation transfer function), a quantity that describes the contrast in a pattern of dark and light lines of various widths. The narrower the lines or the more lines there are per millimeter, the more difficult it is for a display to show them, so the MTF goes down. The MTF is rarely given for displays, so unless you are in a laboratory that can measure MTF, you'll have to get along without knowing it. But the concept is valuable.

How Good Is Good Enough?

To examine a display critically, look closely at a symbol with fine alternating black and white lines, such as the letter *m* in a small font. Notice the brightness of the white lines and the contrast with the black. Are the lines bright and clear, separate and distinct? Use a capital *E* or the = symbol to evaluate horizontal lines. Compare the corners to the screen center. Look for color smears at the edges. View the display screen from different angles.

If you can appreciate the resolution of a 300-dpi printer, you should be able to appreciate a 14-inch monitor with 3000 pixels across its 10-inch row. Of course, it would also have to be bright and have high contrast. If the display were larger, it would need more pixels horizontally and vertically in order to have the same dots per inch. That is why images on small displays and small TV receivers look sharper than those on larger displays. Thus, displays can improve much more before they reach the limit of our vision.

It's amazing the detail your eye can see. It can resolve 380 pixels per inch viewed from 18 inches away. If you don't believe you can see that well, compare a page from a 300-dpi printer with a page in a quality magazine. The magazine looks better. (See "Displays: The Human Factor" on page 195.)

A 21-inch-diagonal display must have about 6000 by 4500 pixels to achieve 380 dpi. But even a 14-inch VGA display, with far less resolution than that, produces clear, readable text and impressive graphics if the contrast is high. For many people, that's good enough. Enlarge that VGA screen to 21 inches, however, and you have only 40 pixels per inch and rows that look much fuzzier than those on the smaller display. Thus, even for less demanding applications, VGA is not adequate for large screens.

The Future

If you believe that today's Super VGA or Macintosh resolution is all you need for most applications, you'll be happy to know that the future will bring better contrast and higher brightness in the larger-size displays, blacker blacks, and color displays that provide images as sharp as those of black-and-white displays. Beyond these improvements, large displays will produce 300 dpi (perhaps 21-inch pictures with 6000 by 4500 pixels), so screens will look like laser-printer output and will be the final word in WYSIWYG.

CRTs will be the first to offer this high resolution, but they will be replaced by flat-panel displays. LCDs will probably be first among the flat-panel displays to have this capability, followed, perhaps, by electroluminescent panels that will eliminate the need for backlighting and the limitation on off-axis viewing.

Further ahead—much further—dream about 600-dpi color flat-panel displays the size of a newspaper that are touch-sensitive over their whole input area. Looking at your display will be like looking at a quality magazine. ■

Michael Lurie is a senior member of the technical staff at the David Sarnoff Research Center (Princeton, NJ). You can reach him on BIX c/o "editors."

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MONOCHROME TO COLOR

Two new techniques have overcome the limitations of conventional color CRT technology

JOE HALLETT

Why color? First, you use it to convey information. With carefully chosen colors, you can communicate information in greater detail and with greater authority than you can with monochrome (*monochrome* commonly means one color or white displayed against a neutral background or—in special cases—one color displayed against a background of another color). Color-coded information is frequently seen in business charts and graphics and in map-based presentations. You can also use color to reproduce rich images.

Also, there is something that just feels good about working with color. Color surrounds us. Movies, TV, games, printed materials, and the world we live in all present an unending stream of visual experiences in color. Many people feel better using a color display even when the image quality is demonstrably inferior to that of a corresponding monochrome display.

Once someone has color, everyone else on the block wants it. Color is an important attribute in the competitive world of electronic displays—not necessarily just for consumer products but also for businesses that want to be perceived as being up with the times.

There are a lot of reasons to use color. One way to obtain it is by converting monochrome images to color using one of several new color display technologies that are entering the marketplace.

Some Basics

Color images that you see in the real world are analog. They contain smooth distributions of the colors of the rainbow. Methods of reproducing these images on a screen or

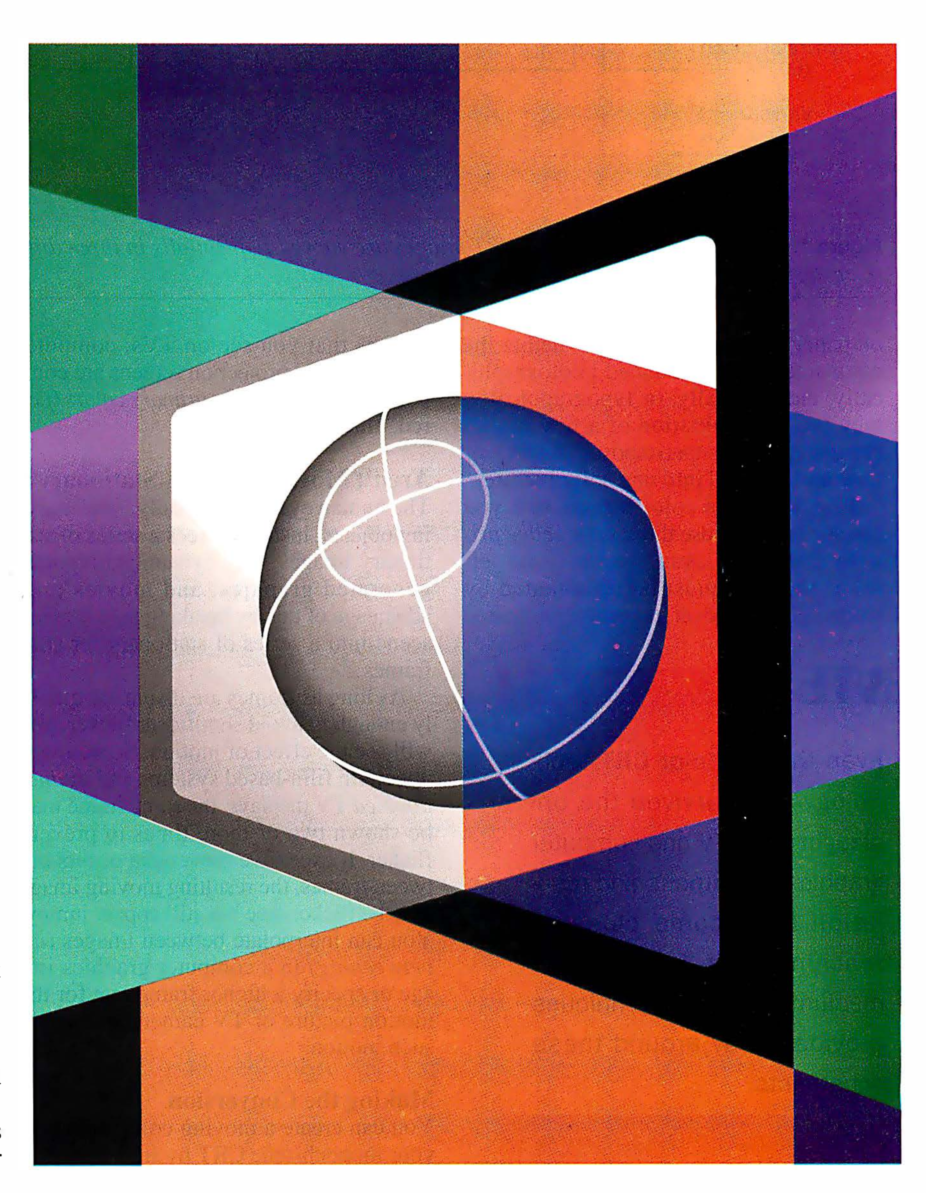


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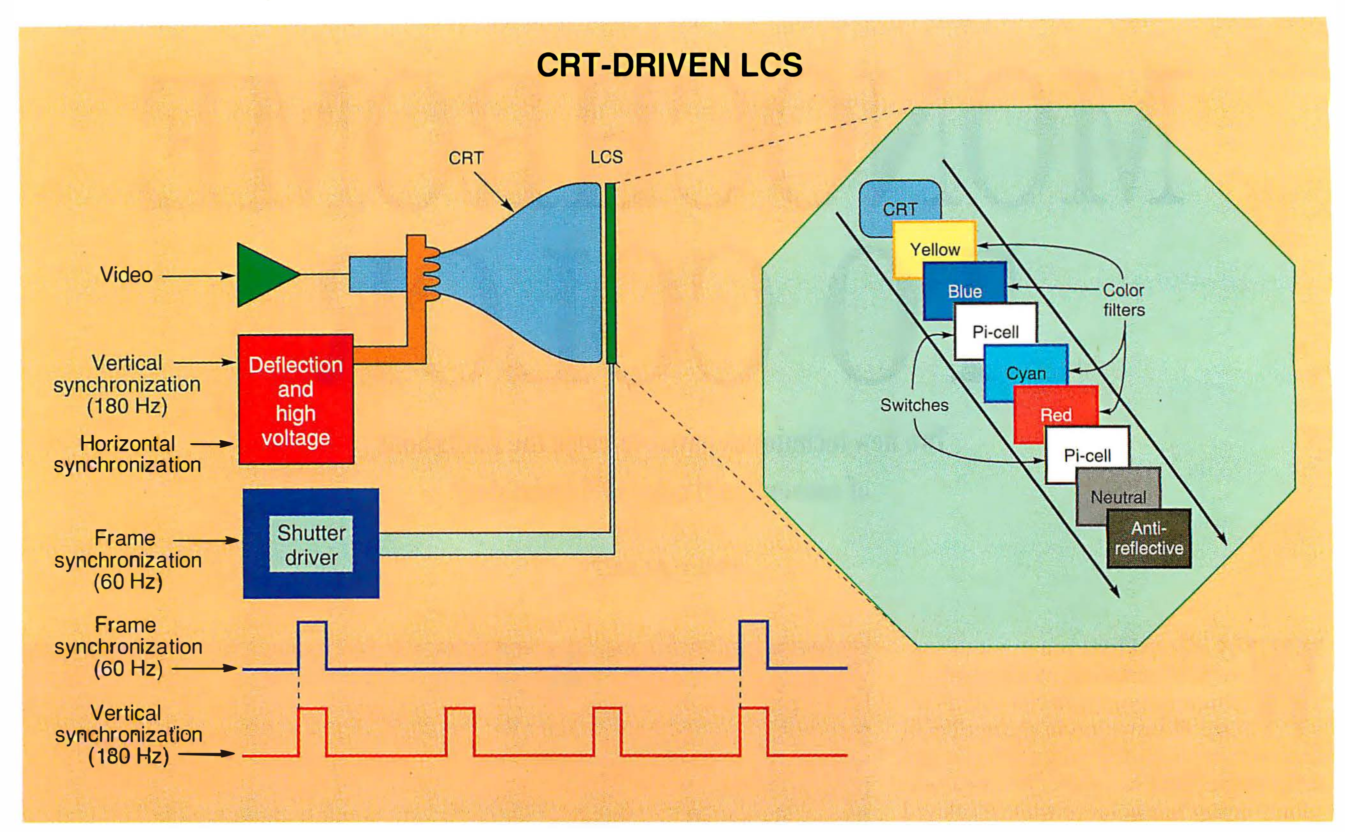


Figure 1: *Three "black-and-white" CRT images are viewed sequentially in three different colors through the LCS. (Courtesy of Tektronix)*

on paper are usually digital. Whether the color images are produced photographically, electronically, or typographically, they are a combination of a few monochrome images, superimposed in space or time and blended into one color picture.

In general, the color images that you can see on paper use three *subtractive primary colors* (i.e., cyan, magenta, and yellow), and they must be illuminated by white light. However, the self-illuminated images that you see on TVs, computer monitors, and projection screens are composed of three *additive primary colors* (i.e., red, blue, and green).

BYTE ACTION SUMMARY

Even though color CRT technology has survived the onslaught of HDTV and computer graphics, brightness and resolution have come close to reaching their limits in this medium. Two new techniques provide a way around these constraints.

Aren't Moving Pictures Stationary?

The human eye doesn't really "see" moving objects; instead, it sees a series of stationary images. TV, dynamic computer-generated graphics, and movies take advantage of this by breaking up a moving scene into a series of stationary, or still, frames.

As long as frames are displayed quickly enough to avoid significant flicker, you will see the effect of motion. Sometimes, in certain film-based systems and in *line-doubled* TV displays, the same frame may be shown two or more times to prevent flicker. If excessive movement occurs between frames, the resulting moving image may be flicker-free but still appear jumpy. You can interpolate between images (*inbetweening*) in a computer graphics image or specify a higher frame rate for the motion-picture or TV camera to capture such motion.

Making the Conversion

You can create a moving color image on your monochrome CRT by simultaneously combining primary-color images into frames. Typically, three electron guns illuminate three phosphors, each creating a separate color image. You can use multiple CRTs, as in TV projectors. If you do, your projector may combine the images internally with a single projection lens, or externally on the screen using three lenses. With only one CRT (as in your computer monitor or TV set), however, conventional color CRTs (known as *shadow-mask* CRTs) integrate the electron guns and phosphors into one tube.

Another technique that is used to produce color images with monochrome CRTs combines monochrome fields sequentially to make each frame. Color filters that are placed between you and your CRT screen select red, blue, and green images that are timed to appear when the proper filter is in place. Instead of using one CRT with a white phosphor screen, you can use a phosphor that has sharply peaked emission at wavelengths corresponding to each of the desired primary colors matched with narrow-band color filters. This approach provides a great improvement in contrast.

A few manufacturers have developed field-sequential displays with electronically switchable color filters using liquid-crystal technology. These filters are often

called *LCSes* (*liquid-crystal shutters*) (see figure 1). To avoid flicker, the field-sequential system must show each of the three images in sequence within the time allowed for a single frame. Thus, the field rate must be three times higher than the frame rate. Despite their ability to deliver high-quality images, field-sequential color systems are not widely used because they incur higher circuit costs and more complex signal interfaces than do simultaneous color systems.

A third technique of converting monochrome to color uses the CRT image to control a separate spatial light modulator, or LCLV (liquid-crystal light valve). In effect, the light modulator is an electronically controlled transparency containing the image developed on the CRT screen. Unlike direct-view CRTs and CRT projectors, this CRT screen doesn't have to produce light energy for viewing, or even light of any particular color. In fact, as long as it can be coupled efficiently to the LCLV, the CRT image can essentially be invisible.

Liquid-crystal panels are commonly used in CRT-driven light valves. These panels are usually continuous liquid-crystal cells coupled with a photoconductive control layer. A CRT illuminates a photoconductor, which in turn creates an image in the liquid crystal. A separate projection light source shining on the other side of a liquid-crystal cell transfers the image to a viewing screen (see figure 2).

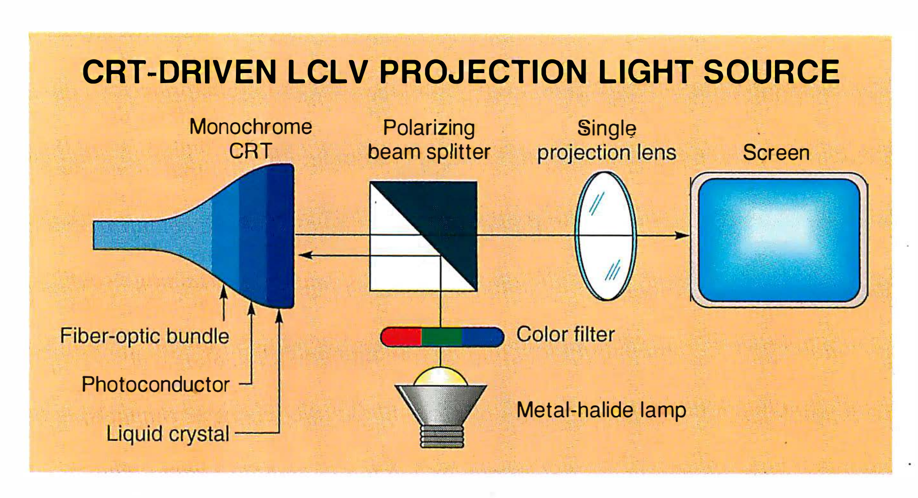


Figure 2: *Three high-resolution monochrome CRTs simultaneously pass images to the liquid-crystal cells through fiber optics and the photoconductive layers. High-intensity red, blue, and green light obtained through filters from the projection lamp is modulated to produce three color images that are combined at the screen (one channel is shown). (Courtesy of Greyhawk Systems)*

LCLV: Simultaneous Color

Much of the original work done on LCLVs was performed by Hughes Aircraft at laboratories in southern California. These efforts led to the introduction of its black-and-white projectors for the Mac shown at the 1987 MacWorld Expo in Boston, Massachusetts. In February, at the Infocom International show in Washington, D.C., some manufacturers introduced full-color projectors for TV and graphics.

Hughes Aircraft's breakthrough came when its scientists used semiconductor materials to fabricate the photoconductive layers in the mechanism, a process that yielded the fast response times and uniformity needed for the display of high-quality motion video. Recently, Hughes Aircraft formed a new company, Light Valve Products (Carlsbad, CA), to exploit this technology. The product is due to ship late this year (see the photo).

Greyhawk Systems (Milpitas, CA), a manufacturer of precision electro-optical systems and devices, has equipped a small high-resolution CRT with a fiber-optic faceplate that serves as one side of a liquid-crystal light-modulator cell. The fiber-optic plate guides light from the CRT to a photoconductive layer. This process "draws" an image that controls the electrical drive to the liquid crystal. A series of filters split light from a projection lamp into primary colors. Each primary color is modulated by its own LCD. This technique produces a composite full-color image. Other firms, including Electrohome (Kitchener, Ontario, Canada) and Xerox (Webster, NY), are reported to also be working on this technology.

The LCS can deliver high-quality color images from a monochrome CRT.

Many technical challenges must be met before such a system becomes a practical product. One goal is to prevent the high-intensity projection source light from contaminating the CRT light. Such contamination would lead to reduced image contrast. Another goal is to obtain acceptably fast response times for displaying moving objects and video. Greyhawk Systems and Hughes Aircraft claim to have solved these problems by using proprietary processes and materials to fabricate isolation layers between the LCD and the CRT.

Other LCLV technologies exist that are not CRT-driven, but they draw heavily on CRT technology to permit direct writing by an electron beam on a control surface. Tektronix's electron-beam-addressed LCLV uses separate electron guns to write and erase images on a liquid-crystal cell that is mounted in a vacuum. This LCLV projects images by using an external light source and polarizers. To date, no products that use this technology are available.

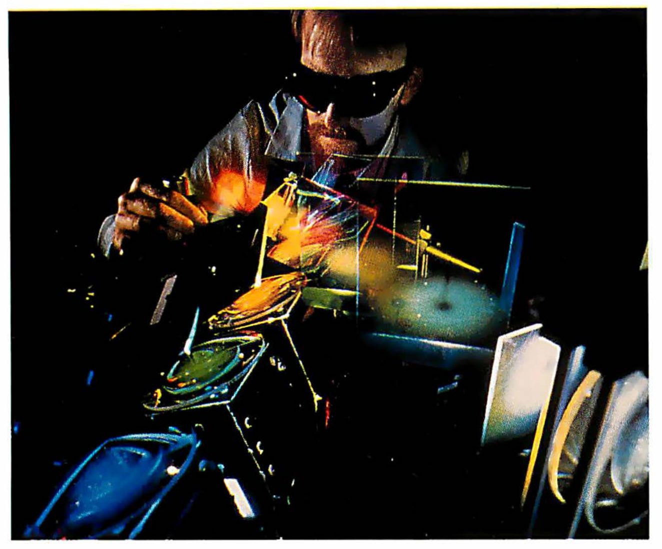
LCLVs produced by General Electric (Syracuse, NY) and Gretag/Eidophor (Zurich, Switzerland) also use an electron beam to write an image. However, they write on an oil film (rather than a liquid crystal) and use external light sources to project bright, large images.

LCS: Field-Sequential Color

At about the same time that microcomputers made their appearance, researchers in the U.K. proposed an electronic equivalent to the color wheel that was based on liquid-crystal technologies.

Before display-equipment designers could use the LCS in practical applications, it had to be made large enough to be used in a direct-view display. It also had to switch on and off quickly for flicker-free field-sequential operation without leaving ghost images. And it had to transmit light efficiently to be bright enough for viewing in normal light.

Tektronix Laboratories (Beaverton, OR) addressed the issue. By the mid-1980s, it had finished development of a fast-switching liquid-crystal panel called the *pi-cell*. High contrast and high resolution were the



Inside the Series 300 projector, light from the Xenon arc lamp is filtered to remove the ultraviolet and hot infrared waves. The remaining "cold" light is then split into primary colors and directed into the color channels. (Courtesy of Hughes Light Valve Products)

strong points of this new technology, which first appeared in Tektronix logic analyzers.

Other applications then fell nicely into place. Kaiser Electronics (San Jose, CA) considered field-sequential color to be a natural option for cockpit displays. CRT displays are inherently more versatile than the mechanical indicators that they replaced. Thus, in its displays for the F-18 aircraft, Kaiser used LCS technology to produce multifunction displays that adapt to the task at hand. They also provide high contrast and saturated color for viewing in a brightly lighted cockpit.

If field-sequential color is an old idea, then so is using the stroke-written, or vector, display in which the CRT electron beam is directed along a precise path rather than using the more common raster-display format. But the vector display uses time efficiently, producing a brighter display than is possible in a raster scan. Kaiser has been able to tune the LCS switching time to optimize light output in each color.

Over the long term, a CRT's physical bulk can prove awkward in avionic cockpits. Richard Hockenbock, general manager of the Tektronix avionic displays business unit, suggests that LCS is an interim technology that will last two to three years for avionic use, after which flat panels will take over.

Two primary colors (red and green) and a mixed color (yellow) have been adequate for color-coded displays, such as test equipment and avionic displays. But extension of the technology to three primary colors has proven difficult, and acceptance has been further hampered by the problems of interfacing field-sequential displays to existing TV and video standards. The situation may be improving. In 1991, at Wescon (San Francisco, CA), Tektronix introduced a 9-inch-diagonal full-color monitor and a series of separate full-color shutters in sizes from 1 to 19 inches diagonal.

Simulating a view of the real world (a goal of virtual reality) becomes a more practical process when the view includes high-quality images. Fake Space Labs (Menlo Park, CA) has used LCS technology to produce high-resolution moving images in small, head-mounted displays.

Status and Potential

Now that addressability beyond 640 by 480 pixels is becoming common for PC and Mac displays, and with HDTV on the horizon, people are becoming more aware of the limitations of conventional CRT-based color displays. Shadow masks and patterned phosphor screens are up against seemingly insurmountable physical barriers. Discrete-element LCD flat panels are making impressive inroads at lower levels of addressability. But this technology also appears to be pushing against physical limitations, as manufacturers pack more and more pixels per square inch into their displays.

This changing environment makes shutter-based displays an attractive return to basics without the fabrication problems of discrete-element display screens. Also, advances in circuit design and fabrication methods make it easier to construct a cost-effective field-sequential switching system, even if you must adapt the interface to an existing display standard. And the large-area LCS should benefit from some of the advances in manufacturing technologies that are being applied to other liquid-crystal devices.

Full-color LCS displays are a recent development that draws from continuing research into materials, manufacturing processes, and electronic circuitry. And the electronic circuitry for a field-sequential display is not likely to be a problem in a new product design. So far, neither the LCLV nor the LCS has achieved wide use, yet their potentials appear to be strong in the absence of any serious competing technologies.

The LCS can deliver high-quality, high-resolution color images from a monochrome CRT in any application that can accommodate the CRT's space and power requirements. Thus, the LCS is a potential contender for use in small-screen desktop equipment. Perhaps it will be the technology that provides photographic-quality displays in products for home, school, and business, whether for personal computers or for multimedia workstations.

The LCLV can take over when you need larger image size or higher brightness—for instance, for group viewing in business workgroups or theatrical settings. New applications include virtual reality and *electronic cinema*, a process that allows high-quality motion pictures to be distributed electronically to your local movie theater.

It Won't Be a Gray World

By departing from conventional CRT usage, the two techniques described here permit the CRT to operate in its most effective monochrome mode. The burden of providing brightness and color is shouldered by other components (i.e., the LCS and the LCLV).

The good news is that there is hope that these specialized components, although they embody highly developed materials and process technologies, may eventually be relatively inexpensive to manufacture. Someday these spatial light modulators may even become available at your friendly radio parts store.

It's been said that the shadow-mask color CRT is one of the most complex products ever mass-produced. Yet color TV sets are one of the few products whose prices have not increased in over two decades. You can expect the consumer electronics industry—particularly as it evolves to include personal computers and related new products—to drive down the cost of these new display technologies into a range that all of us can afford. ■

Joe Hallett is a business consultant who specializes in engineering and business development of display products. The International Communications Industries Association recently published his book LCD Projection Panel Selection Guide. *You can contact him on BIX c/o "editors" or on AppleLink at X2260.*

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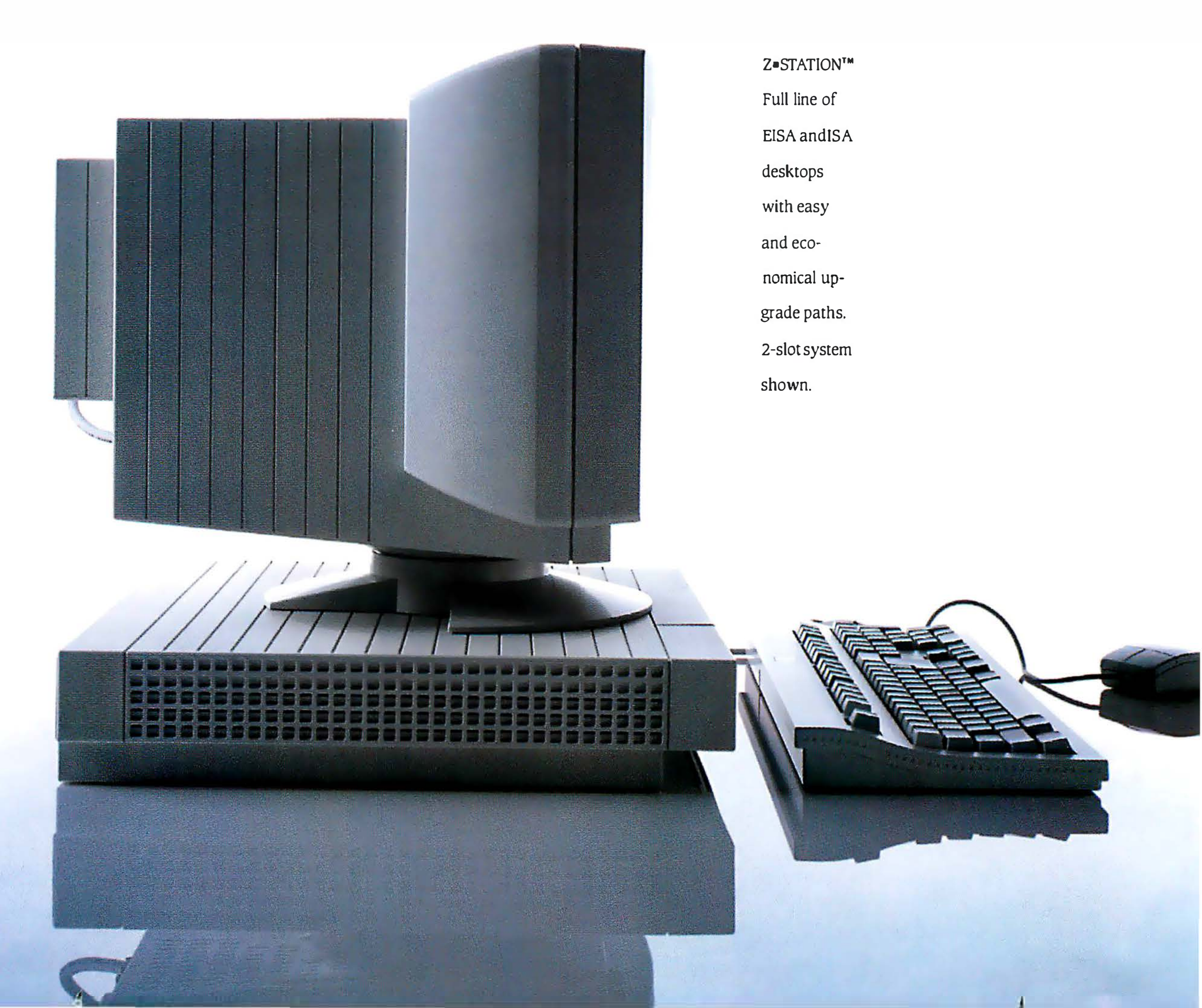


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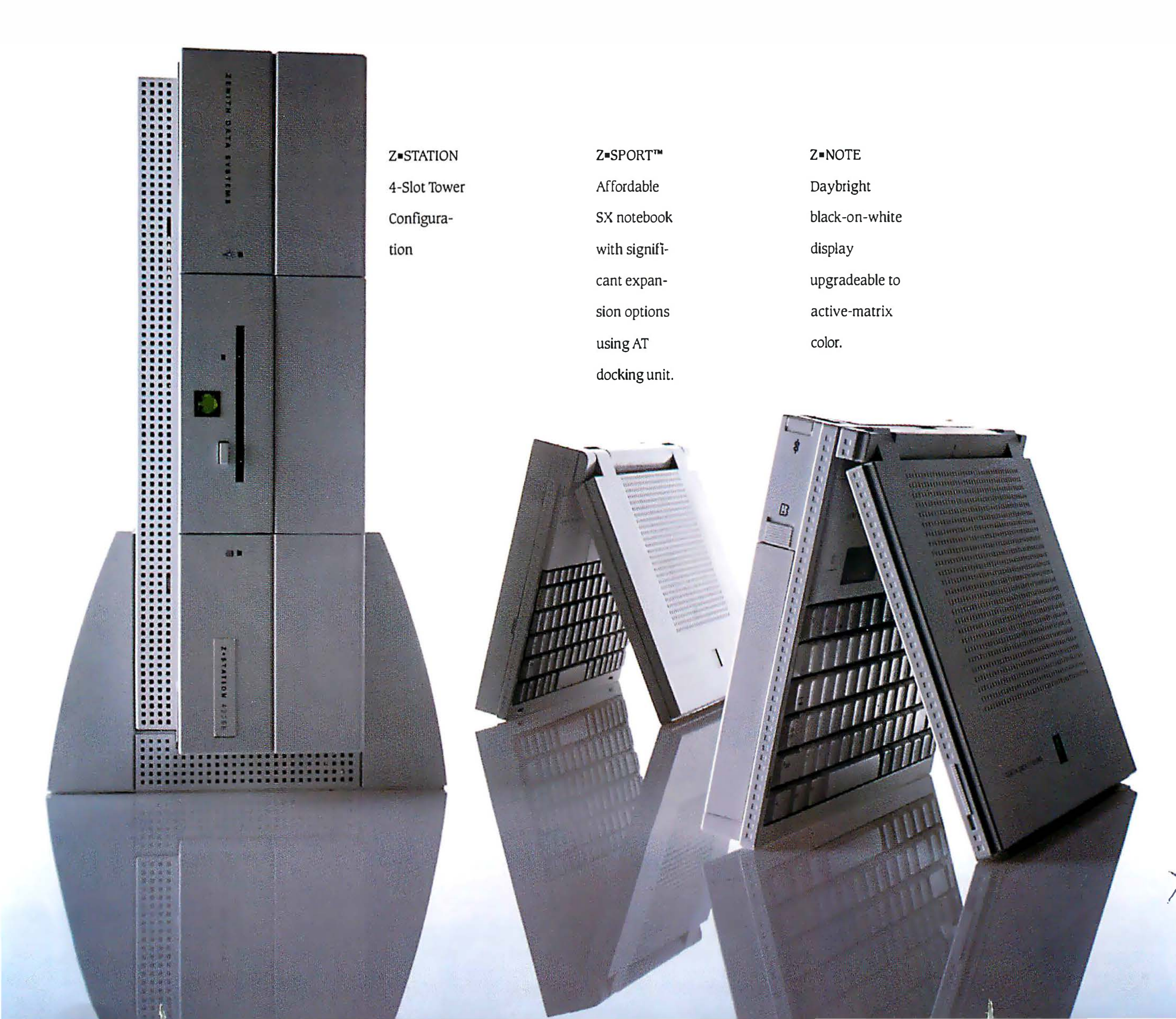
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HDTV IS COMING TO DESKTOP

A new world of high-performance monitors and image-processing software tools is opening up

BERNARD J. LECHNER

Will the coming of HDTV affect personal computer and workstation users? You bet it will. The advent of HDTV will make new technology available to the computer world, and it will generate new applications for personal computers and workstations as they are used to create and process HDTV images. You will benefit from HDTV technology with sharper images and new image-processing techniques, but you'll need more memory, faster hardware, and better displays.

The present NTSC color-TV standard was introduced and adopted a quarter of a century before the personal computer arrived. The new HDTV standard is developing in a different world, and standards bodies must consider the impact of their work on the millions of computers now being used. The FCC plans to choose an HDTV standard for terrestrial broadcast before the end of 1993, and HDTV receivers and broadcasting will be available as early as 1995.

Image Processing and the Computer

The worlds of NTSC TV and the personal computer are interacting at an increasingly frequent rate. You can load standard NTSC images into your computer and process them to the limits of your imagination and creative skill and your system's power and memory. HDTV will expand your capability for such creative activity.

You will be able to take images from TV sources (both NTSC and HDTV) and move them to and from print media with greater ease, and you'll have more powerful tools at your disposal. Also, you will be able to generate and process images for HDTV broadcast, film production, and a

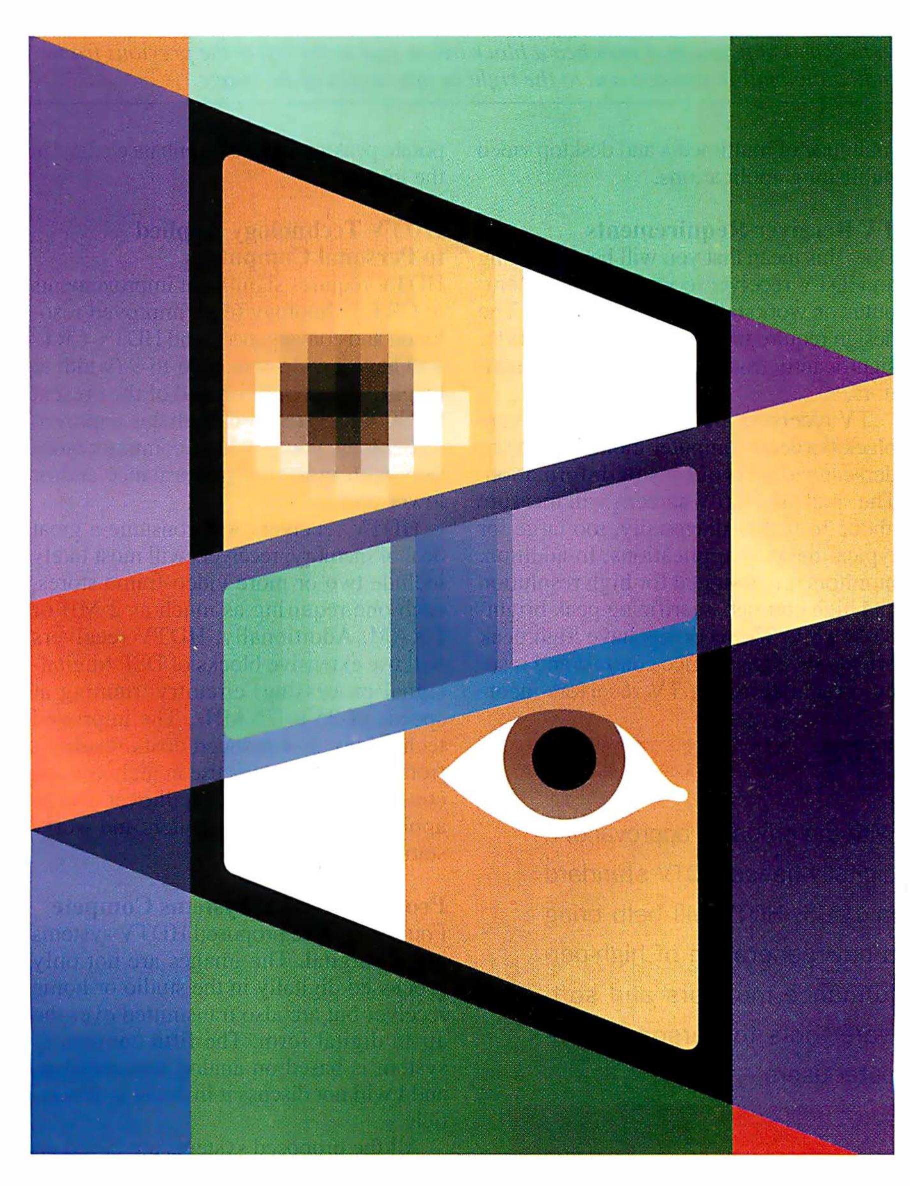
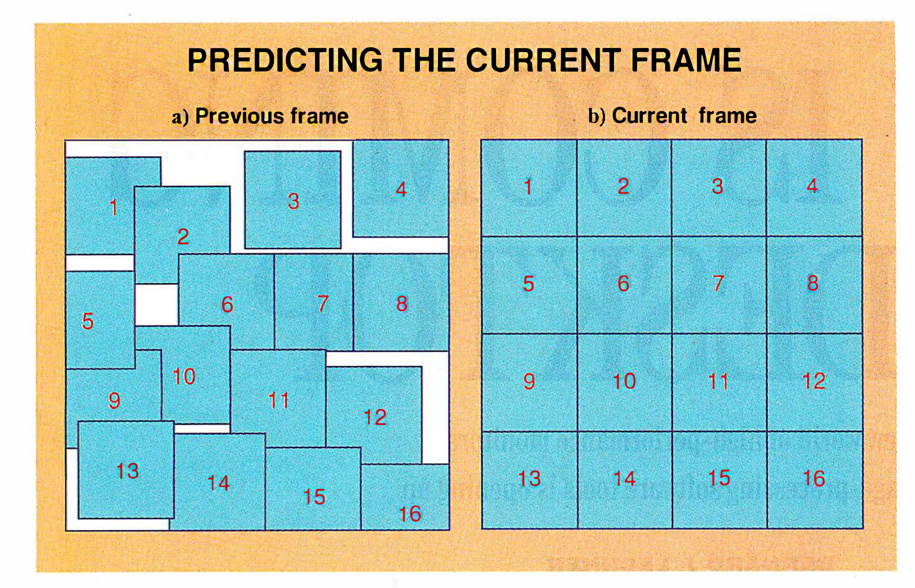


ILLUSTRATION: RON CHAN © 1992



By finding the best match from nearby blocks in the previous frame (**a**), *the receiver predicts the position of blocks of pixels in the current frame* (**b**). *Note that block 2 in the current frame best matched a block below and to the left in the previous frame, indicating motion upward and to the right in this region of the image.*

multitude of multimedia and desktop video publishing applications.

TV Receiver Requirements

Does this mean that you will be connecting an HDTV receiver to your personal computer or workstation? Probably not. The design requirements of TV receivers differ significantly from those of computer monitors.

TV receivers are overscanned to avoid black borders; computer monitors are underscanned to avoid losing information. The smallest HDTV screens will measure about 36 inches diagonally, too large for typical desktop applications. In addition, monitors are designed for high resolution and high contrast, sacrificing peak brightness, while TV receivers have high peak brightness and sacrifice contrast and resolution. Furthermore, TV receivers incorporate peaking circuits to enhance edges in the image.

BYTE ACTION SUMMARY

With the probable approval of a digitally based HDTV standard in 1993, HDTV will help bring a new generation of high-performance monitors and software tools to personal computer users.

HDTV Technology Applied to Personal Computers

HDTV requires significant improvements in CRT technology (e.g., improved resolution and convergence), and HDTV CRTs will have a wide-screen 16-to-9 (width to height) aspect ratio instead of the present NTSC 4-to-3 standard. With this improved technology, you will have computer monitors with improved performance and/or lower cost.

HDTV receivers will consume a great deal of memory; receivers will most likely include two or more video-frame stores, each one requiring as much as 2 MB of DRAM. Additionally, HDTV receivers will use extensive blocks of DSP (digital-signal-processing) circuitry, running at speeds of 25 to 75 MHz. The improved technology and reduced costs resulting from the technology's use in high-volume consumer products will spill over and be applied to personal computers and workstations.

Proposed HDTV Systems Compete

Four of the five proposed HDTV systems are all-digital. The images are not only processed digitally in the studio or home receiver but are also transmitted over the air in digital form. The fifth competing system is based on analog transmission, and I will not discuss it in detail in this article.

All the proposed systems are based on the wide-screen 16-to-9 aspect ratio. A 19-inch diagonal personal computer monitor with this aspect ratio would display two 8½- by 11-inch pages side by side at 80 percent of the full size. You could display 12 columns of a spreadsheet instead of the usual nine.

Two of the proposed all-digital systems use a display-pixel-sampling lattice of 720 by 1280 pixels. A third system uses a lattice of 960 by 1408 pixels, and a fourth system provides two options: 960 by 1440 pixels or 810 by 1440 pixels. At 8 bits per pixel for each of the RGB components, the memory required to store one complete image ranges from 2.76 to 5.96 MB, compared to 0.92 MB for a VGA image. (See the table.)

Pixel Geometry

For computer image processing, logically square pixels offer a clear advantage: Image rotation and scaling are computationally easier with square pixels. However, when displayed on a CRT with discrete raster scanning lines, a logically square pixel-sampling lattice results in displayed pixels that are perceived as being about 20 percent taller than they are wide.

Why the discrepancy between logical and perceived pixel geometry? Because TV uses discrete scanning lines; the vertical resolution of a TV image captured by a camera and displayed on a CRT is reduced to less than the number of original image-scanning lines (the ratio of displayed lines to original lines is typically 0.8 to 0.9 on a modern HDTV CRT display). The factor applied to account for this is known as the *Kell factor*.

Like the VGA display standard, the 720- by 1280-pixel format and the 810- by 1440-pixel format provide logically square pixels. On the other hand, the 960- by 1408-pixel format and the 960- by 1440-pixel format result in perceptually square pixels when displayed on a full-bandwidth, high-resolution CRT monitor.

Digital Transmission and Data-Rate Reduction

The 720- by 1280-pixel systems transmit 59.94 complete images per second using progressive scanning in the camera and display, yielding a data rate of 1.33 gigabits per second. The 960- by 1408-pixel system and the 960- by 1440-pixel system transmit 29.97 complete images per second using 2-to-1 interlace signals, giving a data rate of about 1 Gbps.

How can you transmit such high data rates through a standard 6-MHz TV channel? By using sophisticated digital-modulation techniques, a 6-MHz channel is able to support a data rate of about 20 Mbps.

PROPOSED HDTV SYSTEMS

Some of the important characteristics of the four all-digital HDTV systems proposed for the U.S. terrestrial broadcast TV standard. This data is based on information provided by the proponents to the FCC Advisory Committee on Advanced Television Service and is subject to change as the current test program proceeds.

Proponent organization	ATVA (American Television Alliance) and General Instrument	Zenith Electronics and AT&T Bell Laboratories	ATRC (Advanced TV Research Consortium), Thomson Consumer Electronics, Philips Consumer Electronics, NBC, David Sarnoff Research Center, and Compression Labs	ATVA and MIT
System	Digicipher	DSC-HDTV	AD-HDTV	ATVA-P
Total lines per frame	1050	787.5	1050	787.5
Frames per second[1]	29.97	59.94	29.97	59.94
Interlace	2 to 1	1 to 1	2 to 1	1 to 1
Horizontal scan rate (kHz)	31.469	47.203	31.469	47.203
Pixel-sampling lattice	960 × 1408	720 × 1280	960 × 1440 or 810 × 1440	720 × 1280
Sampling frequency (MHz)	53.65	75.3	54	75.3
Compression algorithm	Motion-compensated transform coding	Motion-compensated transform coding with vector quantization	Motion-compensated transform coding (MPEG-based)	Motion-compensated transform/sub-band coding
RF modulation method	32 QAM[2] with 16-QAM option	2-level and 4-level vestigial sideband	Spectrally shaped 32 QAM with 16-QAM option	16 QAM

[1] All but the Zenith/AT&T systems provide a 24-frame-per-second mode for program material originated on motion-picture film.
[2] QAM = quadrature amplitude modulation.

However, to transmit information at 1 Gbps on a 20-Mbps channel, you have to compress the information by a factor of about 50 to 1.

How can you do that? First, you can discard information that is psychovisually unnecessary: that which can't be seen. Because the human eye is much less capable of resolving color detail than brightness detail, the first step in all the proposed HDTV systems is to convert the RGB representation of an image to a luminance (i.e., brightness) signal and two color-difference signals. The system subsamples the color-difference signals at a ratio of 2 to 1 (in most cases), both vertically and horizontally. You retain only one-quarter of the pixels for each color-difference signal, reducing the transmitted information by a factor of two.

Next, you take advantage of the fact that typical TV images contain redundant spatial and temporal information. For example, if a portion of an image doesn't change from one frame to the next, you don't need to repeatedly transmit the pixels for that part of the image. You merely send them once and then tell the receiver to repeat them.

Even for parts of the image that move, you can reduce the information that has to be transmitted by telling the receiver where in the previous frame groups of pixels in the current frame came from and what small changes they have undergone. By breaking the image down into small blocks, you'll find that for each block in a frame there is a nearly identical block in the next frame that is displaced horizontally and vertically from the present block. These displacements are coded and transmitted as motion vectors, enabling the receiver to predict the next frame from the present frame (see the figure).

Because the prediction of what the next frame will be won't be exact, you should compare the predicted frame with the real frame and transmit the difference signal. The motion vectors and the difference signal can be transmitted with fewer bits than the whole next frame would require. To get the receiver started when you first tune to a channel, to accommodate the scene changes, and to prevent an accumulation of errors, you should periodically send a complete frame without relying on prediction information.

Analysis and Implementation

The next step is to transform the representation of the image in a frame block by block from the pixel domain to the spatial-frequency domain. Here, you typically use 8-by-8 blocks of pixels. This transformation leaves you with an 8-by-8 array of 8-bit coefficients, but if you arrange them in the order of increasing spatial frequency, you'll find long runs of zeros in most images. Then you can use run-length coding to reduce the number of bits you must transmit.

Because the number of recognizable brightness levels decreases with increasing spatial frequency, you can use fewer than 8 bits to quantize the higher-frequency coefficients more coarsely, reducing the number of bits that must be transmitted. Finally, you can represent frequently occurring coefficient values with short code words, and less frequently occurring values with longer code words.

Applying all the foregoing enables you to achieve the required data-rate compression on *average*. But the *instantaneous* data rate is no longer constant. For a simple picture with little or no motion, the instantaneous data rate will be low, but for complex pictures with lots of fast motion or at scene changes, the rate can suddenly become high.

How do you deal with this varying data rate? You use a buffer, writing into it at the variable rate produced by the coding process and reading out of it at the fixed maximum transmission rate of the channel. This works nicely most of the time. But

occasionally, when there is a complex scene with fast motion or at a scene change, the buffer can be in danger of overflowing. If you truncate the input to the buffer, you produce undesirable major picture artifacts.

When you discover that the buffer is in danger of overflowing, you should selectively discard the image information that is psychovisually least necessary. There is a delay in the eye's perception of fine detail in newly presented images, such as in scene changes. If the first frame or two are not at full resolution, you won't notice it. The eye can also be fooled in scenes with rapid, complex motion. Although the eye will track fast-moving foreground objects, some loss of background resolution will not be bothersome.

The MPEG Standard

One of the systems proposed for HDTV broadcast makes use of an extension of the MPEG (Moving Pictures Experts Group) standard to accomplish the compression I have just described. Because the MPEG extension is an international standard that is likely to be extensively applied to compress images for storage and transmission, especially in the computer world, it would be a good basis for the U.S. HDTV standard.

The MPEG standard is based on a layered structure that makes it easy to transfer images between media at various levels of the coding process. The structure makes it unnecessary to go all the way down to the transmitted bit stream or all the way up to the reconstructed picture.

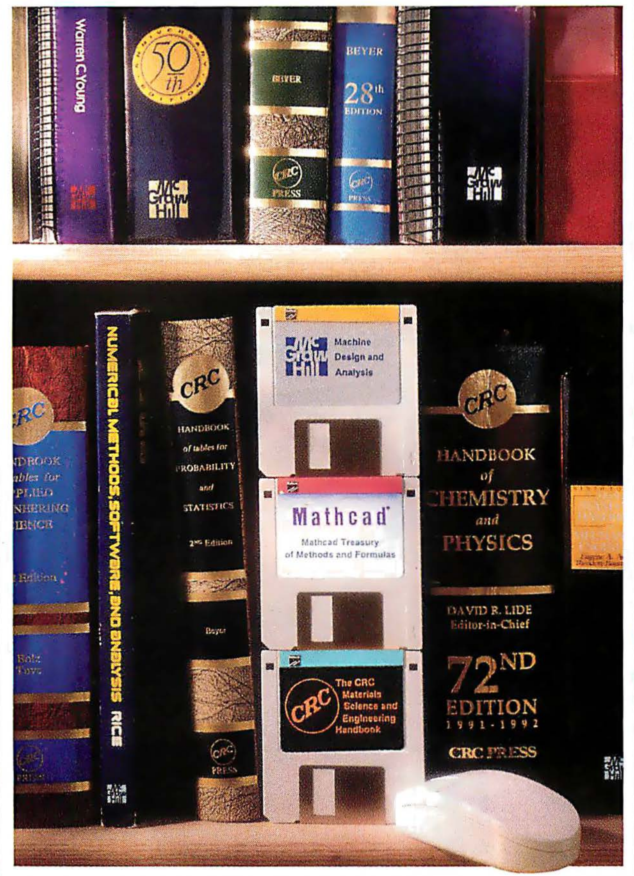
A Profound Effect

HDTV technology is going to have a profound effect on personal computers and workstations. The development of HDTV hardware will result in improved performance and lower cost for CRT-based computer and workstation displays, as well as improvements in memory and DSP technology.

Assuming that the FCC adopts a digital standard for HDTV that is interoperable, flexible, and extensible, it will be possible for personal computers and workstations to easily capture and process, as well as create, HDTV images. A new world of high-resolution image-processing applications will open up, embracing many media, not just broadcast HDTV. ■

Bernard J. Lechner is a consultant based in Princeton, New Jersey, who specializes in TV and video display systems. He was a member of the staff at the RCA David Sarnoff Research Center for 30 years. You can contact him on BIX c/o "editors."

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3	23.2	104	1.20
4	30.8	92.0	1.60
5	38.1	69.0	1.99
6	45.1	44.2	2.38
7	51.5	28.0	2.77
8	57.3	10.0	3.14
9	62.2	12.2	3.50
10	66.1	[illegible]	3.85
11	9.0	6.91	4.18
12	70.0	5.56	4.49
13	71.5	4.67	4.78
14	71.3	4.01	5.04

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0 30 60 90 120
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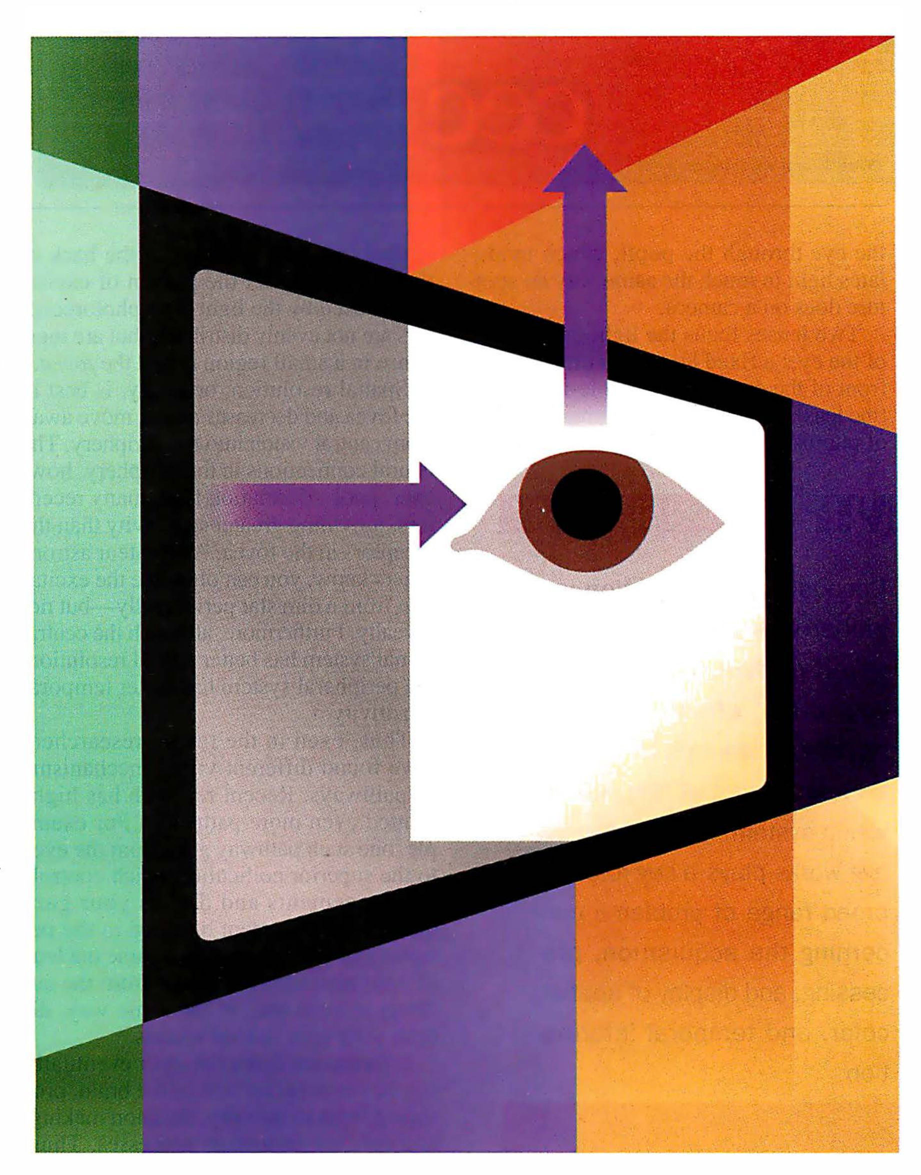
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DISPLAYS: THE HUMAN FACTOR

Recognizing how human vision operates is key to creating outstanding displays

BERNICE E. ROGOWITZ



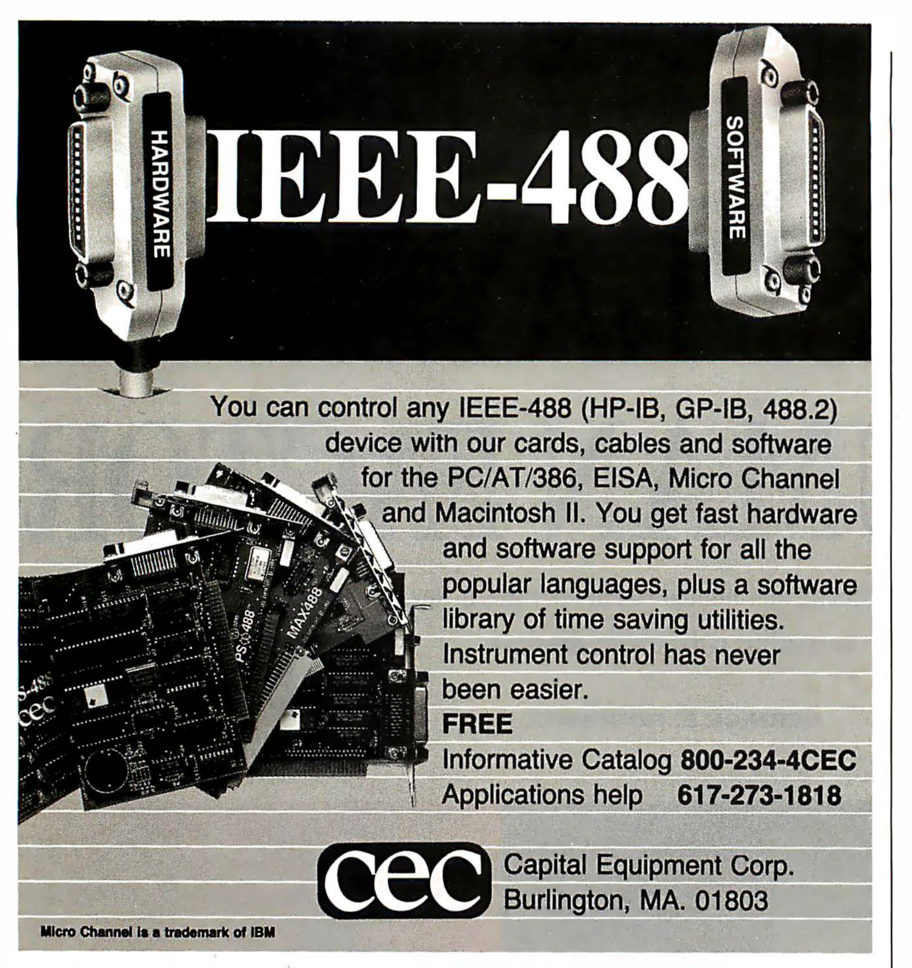
Throughout history, people have created devices for representing, communicating, and displaying information. Some technologies, such as printing, have developed over centuries and evolved a symbiotic relationship with human visual capabilities. Electronic display technology, on the other hand, has evolved at a frantic pace. It's being helped along in its evolution by the application of research into the human visual system.

There are many requirements to be met to obtain good image quality in electronic display systems. You need to create images with sufficient luminance and contrast without causing display flicker. For color displays, you must choose colors effectively and ensure that the information is interpretable. For TFT (thin-film transistor)/LCD monitors, you must minimize the effects of spatial sampling and decide how best to tile the red, green, and blue color pixels. You need to minimize the noise in halftone printing and choose algorithms that achieve good image compression without compromising visual quality. With newer, more advanced technologies (e.g., head-mounted displays), you must understand how to create a convincing impression of depth.

These questions are all technology-oriented, but all hinge on the perception of the human observer. How do you process luminance, contrast, motion, and color? How do these mechanisms constrain your choices of how to capture, sample, compress, and display information?

The Human Visual System

Vision is mediated by a system of neural pathways beginning in the eye and extending throughout the brain. Light enters



the eye through the pupil, which modulates light in much the same way an aperture does on a camera.

Two lenses focus the light on the back of the eye: a fixed lens (the cornea) at the front of the eye and a variable-focus lens (the lens) inside the eye. An irregular array of photosensitive cells, or *photoreceptors* (called rods and cones), line the back of the eye and detect the pattern of excitation caused by the light. The photoreceptors are not evenly distributed but are most dense in a small region called the *fovea*.

Spatial resolution, or acuity, is best in the fovea and decreases as you move away from central vision into the periphery. The neural connections in the periphery, however, pool information from many receptors, providing greater sensitivity than the receptors in the fovea. As amateur astronomers know, you can often see the excitation from a dim star peripherally—but not foveally. Furthermore, although the central visual system has better spatial resolution, the peripheral system has better temporal sensitivity.

Thus, even in the retina, researchers have found different visual mechanisms or pathways. Recent research has highlighted even more pathways. For example, one such pathway goes from the eyes to the superior colliculus, which controls eye movements and directs your gaze quickly to movement detected in the periphery of your vision. This same nucleus of cells also receives inputs from the auditory system and, in the same way, directs your eyes to loud sounds.

Information from the eyes eventually reaches over 60 percent of the brain, providing input to memory, decision making, and concept-formation processes. Thus, designing a display involves more than simply understanding questions of image quality and detectability—it involves understanding how you seek out, understand, and use information.

BYTE ACTION SUMMARY

Because the information you gather with your eyes is conveyed to over 60 percent of your brain, effective display technology requires an intimate understanding of the human vision system. How the human eye works plays a key role in a broad range of problems concerning the acquisition, processing, and display of spatial, color, and temporal information.

Luminance Perception

The human visual system is sensitive to a large range of light intensities, from a flash of light containing just a few quanta to light a trillion times more intense. At any one time, however, you are sensitive only to a small range of intensities, and the visual system adjusts this dynamic range to match the ambient light. You can see this process in operation when you enter a dark movie theater. At first, everything looks dark and formless, but as the neural processes reset the visual system's dynamic range, a full range of intensities gradually becomes apparent.

Luminance perception provides a simple example of how the visual system processes and encodes information. If you increase luminance in equal steps, you find that the *apparent* brightness of these steps doesn't increase linearly. In fact, to create a set of luminances that looks like equal steps of brightness, you must present a series of geometrically increasing values. Something like a diminishing-return function is at work in the perception of luminance. Jacques Roufs of the Institute for Perception in the Netherlands recently wrote about the importance of this luminance nonlinearity (called the *gamma function*) for image quality. Roufs's work is now a fundamental part of many quantitative models of human vision and image quality (see reference 1).

Spatial Vision and Image Quality

Another important concept for display technology is contrast. The ability to read text, for example, depends mainly on the luminance ratio between the characters and the background. Knowing the contrast between two regions of the visual field, however, is not enough to fully characterize contrast sensitivity.

In the 1950s, an RCA TV engineer by the name of Otto Schade measured how contrast sensitivity depends on the spatial distribution of bright and dark regions. He measured the minimum contrast required to detect grating patterns of varying spatial frequency. His classic result shows that people are most sensitive to luminance modulation, or contrast, at two to four cycles per degree of visual angle and that this sensitivity drops off for higher and lower spatial frequencies.

This relationship has been important in image compression. The idea is to devote the greatest bandwidth to ranges of spatial

frequency where people are most sensitive and compress the image in ranges where they are least likely to detect the change. Another application, commonly used in digital halftoning, is to hide the sampling noise in regions where people are least sensitive and are unlikely to detect it.

Fixing Flicker

The spatial information on a display is modulated in time, depending on the refresh rate of the CRT, the persistence of the phosphor, and the interlace pattern of the fields. When the temporal modulation gives rise to the perception of temporal intermittence, it is said that the display "flickers." Perceived flicker also depends on the luminance and size of the display and whether you look at the screen directly (i.e., foveally) or out of the corner of your eye (i.e., peripherally).

Several researchers have proposed methods for evaluating display flicker. In our lab, my colleagues and I developed a method of evaluating how display parameters contribute to flicker (see reference 2). Measuring a wide range of display parameters for each display, we were able to develop a model characterizing perceived flicker as a linear function of five key display parameters: luminance, refresh rate, interlace mode, phosphor persistence, and color. This equation lets display designers predict the level of perceived flicker and evaluate the costs or benefits of various display design changes.

This work shows how interlaced and noninterlaced displays compare in producing perceived flicker. Two predictions are plotted in the figure on page 198. If the amount of perceived flicker depended on the number of times a field was updated, a 55-Hz/110-Hz (frame rate/field rate) interlaced display would appear to flicker as much as a 110-Hz noninterlaced display (top curve). If interlaced display flicker depended on the frequency of the odd or even fields, the 55-Hz/110-Hz display would appear to flicker as much as the 55-Hz display (bottom curve). The result is close to the split-the-difference line.

All other display parameters being equal, a 55-Hz/110-Hz interlaced display appears to flicker as much as a 78-Hz noninterlaced display. This result is important because display cost closely follows the field rate. Thus, a 55-Hz/110-Hz interlaced display will cost a lot less than a 78-Hz noninterlaced display.

Perceived flicker increases linearly with the logarithm of luminance, which means the brighter the display, the more it appears to flicker. On the other hand, acuity, although dependent on luminance, is mainly dependent on contrast, the ratio between the luminance of the characters and the luminance of the background. A good solution would be to decrease overall luminance without decreasing contrast.

An inexpensive way to achieve this effect is to use a display with a low-transmissibility faceplate. With such a faceplate, light emitted from the phosphors passes through the neutral-density glass once, but light striking the screen passes through the neutral-density glass twice—once on the way in, and once on the way out. The result is decreased overall luminance and increased contrast.

Color Concepts

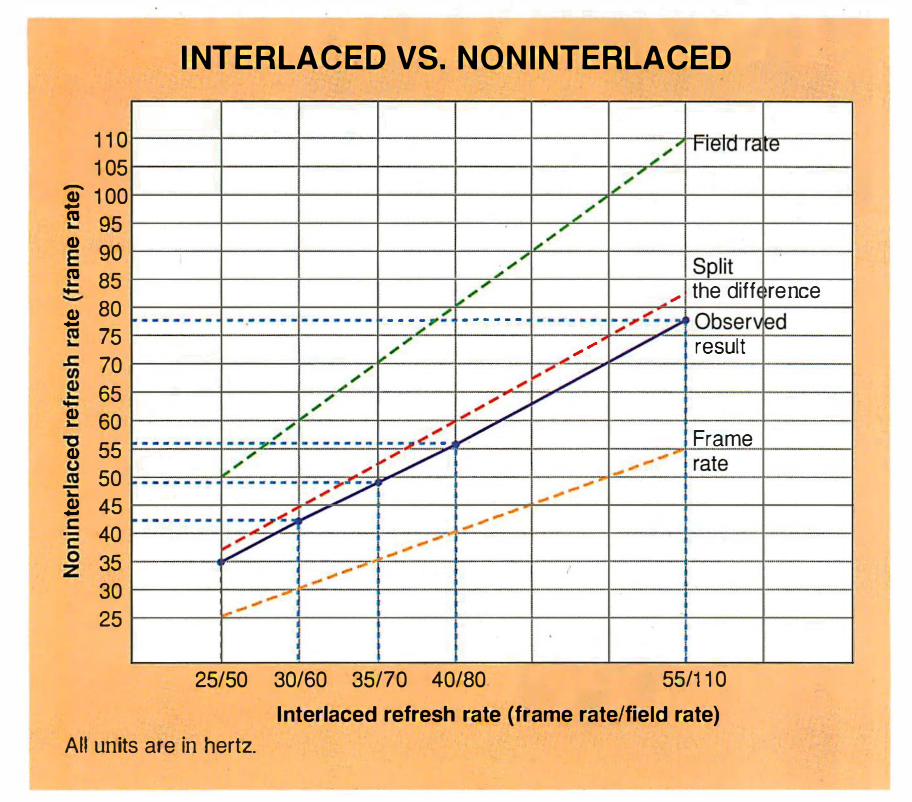
The first stage of the human color-recognition system is mediated by three populations of photoreceptor cones in the retina that can be thought of as broadband filters tuned to three ranges of wavelengths. Sometimes these are referred to as blue, green, and red cone mechanisms, but this is a misnomer for two reasons. First, each color photoreceptor cone mechanism by itself is color-blind. The hues you see depend on the relative outputs of the three cone types. Second, although the short-wavelength mechanism peaks at a wavelength you would call "blue," the green and red mechanisms are largely overlapping and peak at a wavelength you would call "yellow."

This trichromatic system makes possible both color TV and color displays. Because the color you see depends on the pattern of activity across the three mechanisms, it's possible to create any color with only three signals. This system of three color-sensitive filters produces the great range, or gamut, of colors you see.

But what about color-blind people? How do you select colors that won't handicap them? A good rule of thumb is to make sure that the distinction you want to make has both a color and a luminance difference. Thus, even if someone can't use color cues to see the distinction you want to show, there is a redundant luminance cue. For example, it would be a good practice to make all the spelling errors that have been identified by a spelling checker appear both red *and* bright on the screen, rather than just one or the other, as many programs now do.

Luminance and Color

By adjusting the background and foreground colors on a display, you discover that some color combinations produce unreadable text. Yellow characters on a white background, for example, are indecipherable, but yellow on a wide range of other colors looks fine. This is because our visual systems process color and luminance differently. You can detect fine spatial variations in luminance but only coarse spatial variations in color. Detecting yellow text



Data from flicker-matching experiments shows that the perceived flicker of a noninterlaced display is equivalent to 0.702 times the field rate of an interlaced display, all other variables being equal. Thus, a 55-Hz/110-Hz (frame rate/field rate) display appears to flicker as little as a 78-Hz noninterlaced monitor.

on a white background is difficult because there is little difference between the luminance of the text and that of the background. Because the luminance mechanism has high spatial resolution, it has nothing to work with. The spatial frequency of the text is beyond the spatial-resolution limits of the color system, so you see something yellowish but can't make out the text. This phenomenon also holds true for dark-blue text on a black background or for any situation where the foreground and background of a high-resolution image are isoluminous.

High-resolution images require luminance variations, which can be colored luminance variations. For example, a bright foreground color on a dark background color would be detectable. This knowledge can be useful in solving some practical problems. For example, Al Ahumada and Heidi Peterson of NASA and IBM Research, respectively, recently showed that, for image compression, you can treat the red, green, and blue planes of a colored image as if they were simple luminance images, ignoring the hue completely, and arrive at appropriate coefficients for the quantization matrix (see reference 3). Detection of high-resolution images depends only on luminance.

Other compression schemes make use of another property of spatial frequencies: The range over which the luminance system operates is greater than the range over which the color mechanism operates. Thus, in coding information, less bandwidth needs to be devoted to color.

This concept is fundamental to several standard image-coding schemes (e.g., YIQ, or luminance-chrominance) and explains how it was possible for TV engineers to add color to black-and-white TV technology. The bandwidth required to transmit full color was so small that information could be squeezed between the bands carrying luminance information. Compression schemes that devote most bandwidth to luminance and a smaller bandwidth to color information can achieve higher image quality with fewer bits.

In focusing on high-resolution issues, you shouldn't forget that color mechanisms are especially sensitive to low spatial frequency (i.e., large areas). Anyone who's ever used a pale-salmon-colored paint to cover a large wall knows that the larger the area, the more saturated and intense the color looks. On a large wall, the pale salmon can look like a mango frenzy. Conversely, a beautiful full-sky sunset can look wan and flat in snapshots.

In my judgment, this phenomenon is why most nature photographers prefer slides, which can be projected onto a large screen, providing a suitable stimulus for the color mechanisms. In addition, I think this factor leads the proponents of projection technologies and HDTV to believe that the images these technologies produce are better than the images produced by other technologies, even though the spatial resolution of those images may not compare to those of other technologies.

Another application of this information is for windowing environments. Because windows tend to be large, you can easily see small differences in hue. It's not necessary to use jarring, saturated colors to distinguish between windows. Subtle variations in window color should be adequate.

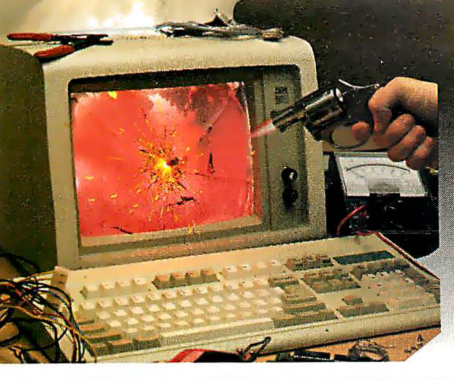
Device-Independent Color

An important area emerging in display technology is the creation of color images that look comparable when displayed on a CRT display, projected onto a screen, or outputted from a printer. One critical factor in achieving this goal is the calibration of your output devices.

Characterizing an image in terms of the D/A value sent to the red, green, and blue electron guns doesn't let you control the color unless you know the luminance-response function for each of the primary colors of your display. Measuring these functions is straightforward, and once you have performed this computation, you can express the chromaticities of your image in terms of a number of standard metric spaces and manipulate the colors in systematic ways. But be careful. These red, green, and blue values are luminance values, not D/A values. If there isn't a linear transformation between your D/A values and your luminance values, the transformation will be uninterpretable.

The second aspect of achieving device-independent color comes after the individual devices are calibrated and you want to transform color information from one device to another. Often the standard transformations are impossible to perform, because the printer and the CRT operate at different luminance levels and the range of available colors decreases at low luminance levels. Also, the color pigments or phosphors may create different gamuts of colors that are not fully overlapping.

To date, technologists have made various simplifying assumptions when trying to match output across devices, selecting, for example, the closest available color. But should that color be closest in hue, saturation, lightness, or all three? Should



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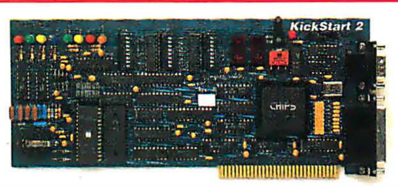
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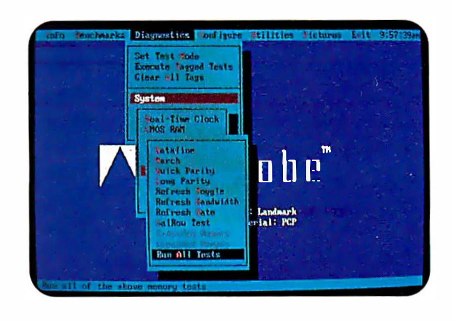
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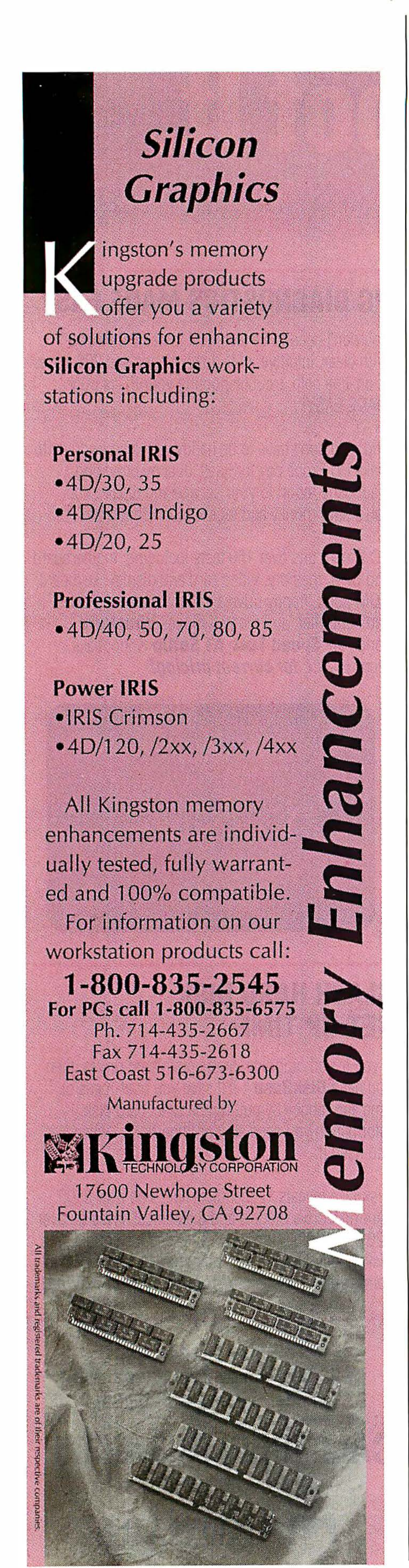
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you try to find the closest match or transform all the colors to better fit into the new device's gamut? These and other questions are open to debate, and the answers will come only from measurements of what you see.

Perception and LCDs

The information presented on a display screen is not a continuously varying image, but an image made up of dots or rectangles that provide samples of the image. In early displays, designers were limited in the number of points they could individually address on each scan of the display surface—a situation that resulted in *punctate* (i.e., marked with tiny dots) characters. As the technology developed, the number of dots allocated for each character increased; today, high-resolution bit-mapped displays let you use various fonts and styles and produce fine-looking images.

Perceived flicker increases linearly with the logarithm of luminance.

One technique important in overcoming the limitations of sampling is the use of gray scaling, or antialiasing. This process lets you digitally apply a low-pass filter to characters and images, eliminating some of the high-frequency splatter created by the sampling process.

Liquid-crystal technologies provide the most active arena for combating the effects of spatial subsampling. Unlike CRT displays, LCD pixels are spatially distinct, not overlapping. Also, LCD color doesn't come from mixing color in each pixel but by creating a matrix of pixels, each colored red, green, or blue. Furthermore, each pixel is separated from its neighbors by a thin black region, enhancing the tiled, sampled appearance of the display.

As with CRT images, it has been shown that gray scaling can soften some of the sampling effects. The problem is that creating gray scales is difficult for LCDs. Using a CRT display to simulate a color TFT/LCD monitor, my colleagues and I showed that character detectability and perceived image quality increase monotonically up to 3 bits of gray scaling (8 luminance levels) and then an asymptote. For text, it may be possible to reduce the effects of sampling by adding as few as 3 bits of gray scaling.

The other problem introduced by TFT/LCD monitors is deciding how to tile the red, green, and blue picture elements. My colleagues and I have found that any configuration that biases the representation (e.g., by aligning the pixels so that orientation is not sampled evenly) produces a marked decrease in visual detectability and pattern identification.

Visions of the Future

Human vision plays a key role in a broad range of problems that concern the acquisition, processing, and display of spatial and temporal information. As the technology advances, there will be an even greater need for vision science. The types of problems, however, will change as the technology changes.

As information about the luminance, contrast, flicker, and color sensitivity of the human visual system becomes incorporated in display design, new questions will arise—questions about new display technologies, richer computer environments, spatial/motor interactions, interactions between the sensory modalities, and ways to attract and focus attention.

As people develop systems that support interactive exploration of data, they will need to understand how to conceptualize and represent data so that it facilitates human analysis and thought. The interaction between experimental psychology and display design is in the infancy of a life that promises to be very interesting. ■

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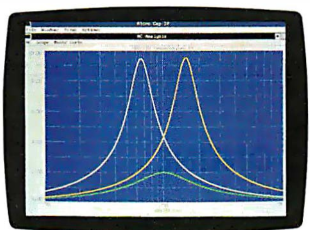
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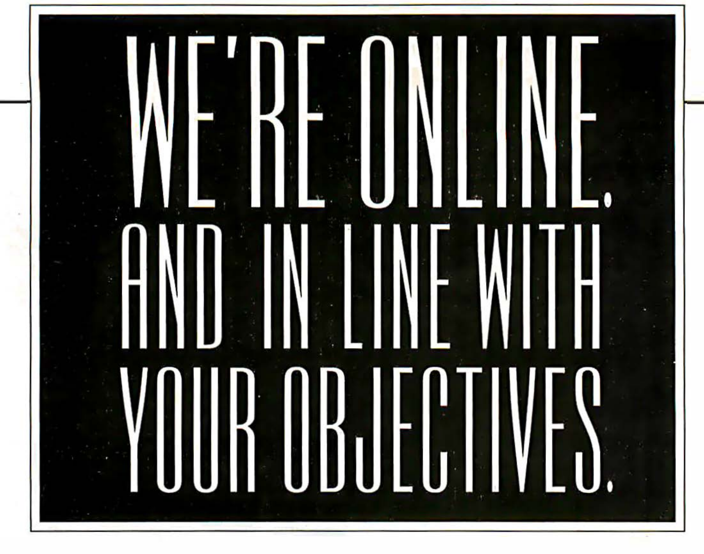
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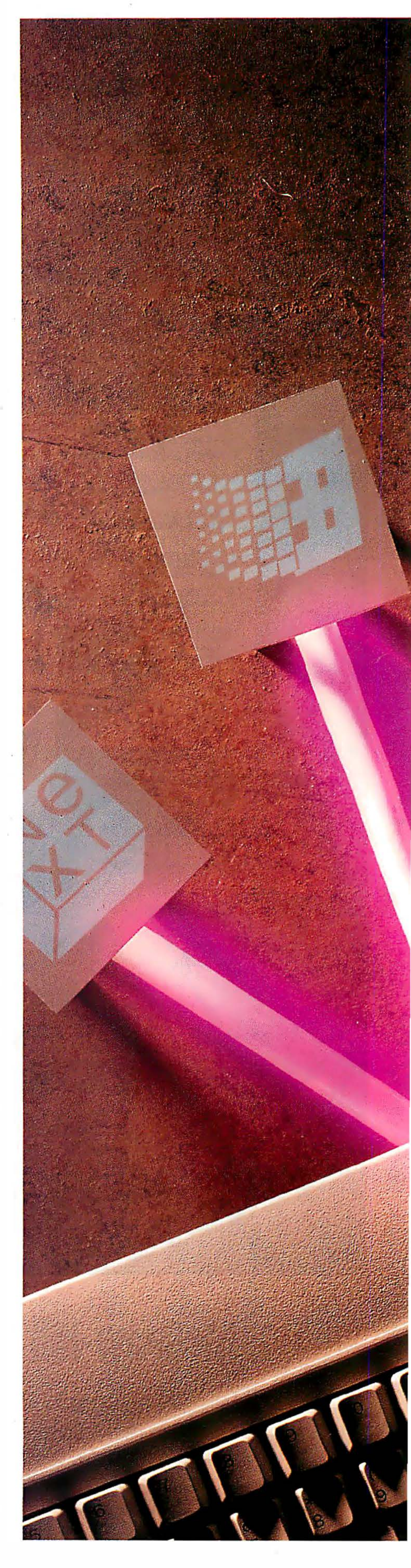
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CODE ON THE MOVE

The BYTE Lab tests seven portable user interface libraries and tells how to choose the one that best fits your needs

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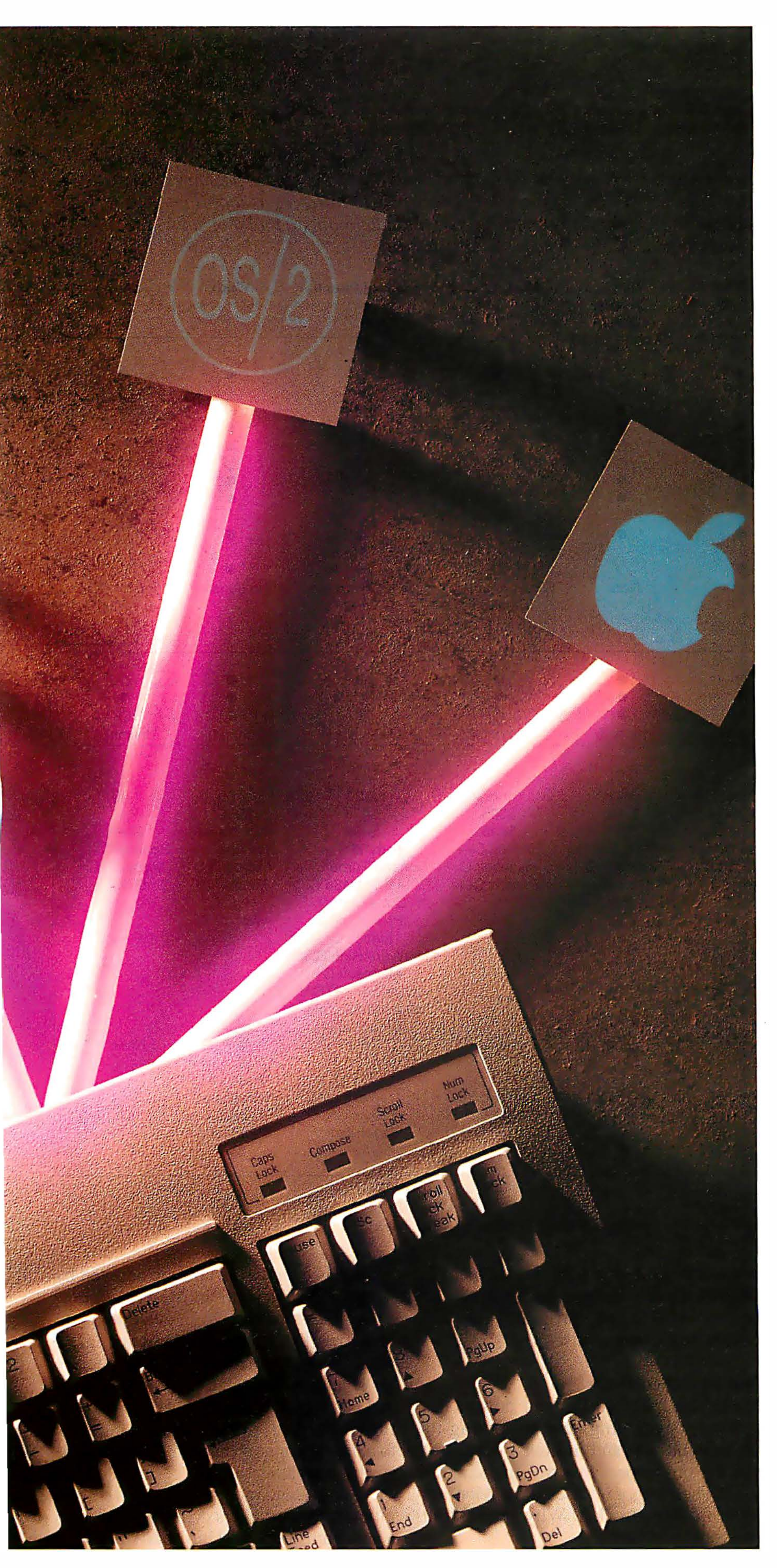


It suddenly comes to you, a software product that is so exquisite, so simple, so necessary to everyday life, that it is sure to make you rich, famous, and an instant folk hero for future generations of programmers. However, you must resolve one important issue: For which computing platform will you target your masterpiece: the elegantly integrated Mac, a PC running Microsoft's runaway hit Windows, plain-old-vanilla DOS, or the Unix and/or OS/2 environment?

Wouldn't it be wonderful if you could write a single application and have it miraculously transported to every platform? In short, write code that's totally portable. That's just what portable libraries do. This month, the BYTE Lab looks at seven of them and chronicles their strengths and weaknesses. (For a capsule summary, see "Pros and Cons of Portable Libraries" on page 210.)

Portability comes in many guises. There is source code portability, which ensures that programs written in one language on one platform will compile and execute identically on another. Today, ANSI Standard C is the best-known example. Another approach is portability at the object code level. The most famous (and most successful) avenue to this kind of portability was the UCSD Pascal operating environment, which ported an operating shell, editors, and compilers through the use of low-level pseudocode. Implement a pseudocode interpreter on your machine and you instantly had access to a complete development system.

Another tactic is to port the operating system. This makes the portable source code method simpler, since you need only recompile to accommodate the new processor being used. All your system calls are identical. This is the method advocated by various Unix groups. In particular, the availability of Posix-compliant systems ensures (theoretically) that the Unix calls you make on platform A are identical to those on platform B. The move to portable operating systems is also being expounded by such companies as Microsoft, Apple, and IBM with their Windows NT (New Technology) and Pink/Taligent products. Of course, if simply having an



BYTE ACTION SUMMARY

■ **WHAT PORTABLE INTERFACE LIBRARIES DO**
They provide a uniform programming interface on multiple platforms that allows developers to port applications without having to rewrite code.

■ **LIKES**
Most of these products offer a simplified interface to the GUI environment. Two of them port the familiar Windows API.

■ **DISLIKES**
Slow speed and size overheads are particularly noticeable when working on a 16-MHz 386SX.

■ **RECOMMENDATIONS**
XVT provides the highest portability among platforms. Wndx allows complete control over look and feel on any platform.

operating system available on multiple platforms were the answer, everyone would be running Unix. Instead, we live in a tangled world of multiple standards.

The growing popularity of GUIs has complicated the portability question. No two GUIs are the same. Each has its own look and feel. Window styles, mouse actions, and menu arrangements all differ. For your product to be accepted, it must acquire the proper look and feel of each environment. Having a killer application on a Mac that looks like a Windows application will not get you rave reviews or many sales.

Many Means to an End

This month's Solutions Focus examines the different approaches taken by portable user-interface libraries. CommonView3 from ImageSoft and XVT from XVT Software port applications primarily among various graphical platforms. Two packages, the Mewel Window System from Magma Systems and Windows.Txt from Interactive Engineering, port the GUI to an equivalent textual interface. Wndx from Wndx Corp. builds the portable interface and allows custom interfaces to be moved to any supported platform. Panel Plus II from Roundhill Computer Systems takes the novel approach of porting a textual interface to a graphical environment. Inmark Development's zApp provides a C++ wrapper for the Windows API that can then be ported using third-party interface tools. Each approach has its own rationale,

PORTABLE LIBRARIES AT A GLANCE

The widely varying audiences for which these libraries are intended make it inappropriate to compare packages strictly on a feature-by-feature basis. As with any development purchase, you must consider these libraries as tools that are suitable for specific purposes. Picking the proper tool for the job is more important than finding a tool that solves all your problems. (● = yes, ○ = no, N/A = not applicable.)

	CommonView3	XVT	Mewel Window System	Windows.Txt	Panel Plus II	Wndx	zApp
General information							
Supports Windows MDI?	●	●	●	●	○	●	●
Built-in forms-processing support standard?	○	○	●	○	●	○	●
Portable help?	○	●	●	○	●	●	○
Built-in macro support?	○	○	○	○	○	●	○
Built-in portable undo?	○	○	○	○	○	○	○
Portable icon resources?	○	○	●	○	○	●	●
Portable string resources?	●	●	●	●	○	●	●
Portable application configuration file?	○	●	●	●	●	●	○
Must other files (e.g., DLLs or shared libraries) be distributed?	●	●	○	○	●	●	○
Single price buys following bundles	None	None	None	Windows support is inherent	DOS, Windows, OS/2	No bundles	zApp for DOS and Windows zApp for OS/2 and Windows
Developer support							
On-line help?	●	○	●	●	●	●	○
Native user interface?	●	●	●	●	○	●	●
Custom user interface?	○	○	●	○	●	●	○
Free technical support	Unlimited	12 months	1 month	2 months	Unlimited	3 months	Unlimited
Platform-specific information							
DOS							
Version	N/A	3.00	3.41	1.20	2.20	2.00	1.00
Price	N/A	$1450	$295	$395	$495	$995[3]	$495
Price with source code	N/A	Not stated	$595	$695	$495	Not stated	$495
Supported compilers	N/A	Borland C++ Microsoft C Zortech C++	Borland C/C++ Microsoft C JPI TopSpeed C Zortech C++	Borland C++ Microsoft C Zortech C++	Borland C++ Borland Turbo C++ Intel 386/486 C Code Builder JPI TopSpeed Lattice C MetaWare High C 386 Microsoft C Microsoft FORTRAN Watcom C/C386 Zortech C++	Borland C++ Microsoft C MetaWare High C Watcom C	Borland C++ Microsoft C Zortech C++
Run-time royalties	N/A	None	None	None	None	Yes. First 1000 copies are free.	None
Display mode	N/A	Text	Text and graphics	Text	Text	Graphics	Text
Built-in EMS	N/A	○	●	○	Compiler-dependent	Compiler-dependent	○
Built-in printer support	○	●	●	○	○	○	○

[1] This package duplicates Windows functionality. Portability is implicit.
[2] Text and graphics versions available separately.
[3] Wndx for DOS: $295, DOS 286 $495, DOS 386 $595. MetaGraphics library (required for DOS) $995. Combined package: $1395

which needs to be considered when you purchase an interface library.

In order to get a feel for how each of these development libraries approaches the portability issue, we asked each library vendor to implement a program we call BytePort (see the text box "BytePort Demonstration Program" on page 212). BytePort is a simple program designed to demonstrate the different approaches to portability espoused by these packages. Because the functionality and market for these libraries vary so widely, it really doesn't make sense to try to rate them in head-to-head competition. Instead, we have looked at each program's performance on its own terms.

Not Invented Here

Microsoft spent millions of dollars designing, developing, and promoting its GUI, Windows, and millions more convincing developers to write applications for it. Three major releases later, Windows took off like a rocket. Why should you reinvent the wheel?

This is exactly the attitude adopted by Magma Systems with its Mewel Window System and Interactive Engineering with Windows.Txt. Whatever you like or dislike about Windows, Microsoft has devoted a lot of engineering time to its development and has sold a lot of copies. Isn't it simpler, then, to move the programmer's interface to a number of new platforms and not worry about creating yet another interface?

The advantages of this approach are significant. Programmers do not need to learn a new environment. Third-party interface

PORTABLE LIBRARIES AT A GLANCE (continued)

	CommonView3	XVT	Mewel Window System	Windows.Txt	Panel Plus II	Wndx	zApp
Microsoft Windows							
Version	3.00	3.00	Note[1]	Note[1]	2.20	2.00	1.10
Price	$499	$1450			$495	$995	$195
Price with source code	Not stated	Not stated			$495	Not stated	$295
Supported compilers	Glockenspiel C++ Borland C++ Microsoft C++ 7.0	Borland C++ Microsoft C Zortech C++			Borland C++ Microsoft C Watcom C 8.5 Zortech C++ 3.0	Borland C++ Microsoft C	Borland C++ Microsoft Zortech C++ Others
Run-time royalties	None	None	None		None	Yes. First 1000 copies are free.	None
OS/2							
Version	3.00	3.00	3.41	1.20	2.20	N/A	N/A
Price	$499	$1450	$295	$395	$495	N/A	N/A
Price with source code	Not stated	Not stated	$595	$695	$495	N/A	N/A
Supported compilers	Glockenspiel C++	IBM C2	Borland C++ IBM C Microsoft C Microsoft FORTRAN	Microsoft	IBM C Microsoft C Microsoft FORTRAN	N/A N/A N/A	N/A N/A N/A
Run-time royalties	None	None	None	None	None	N/A	N/A
Text/graphics	Graphics	Text and graphics	Text	Text	Text		
Unix							
Version	Platform-dependent	3.00	3.41	1.20	2.20	2.00	N/A
Price	$5000-$25,000	$1450/$4400[2]	$995	$695	$495	$2495	N/A
Price with source code	Not stated	Not stated	$995	$995	$495	Not stated	N/A
Supported platforms	Sun SPARC HP-UX9000/700 i386/486 System V Release 4 Open Look DEC Ultrix SCO/Open Desktop Mips-based machines RS/6000	HP-9000/300&400 Mips 386/ix SCO Sun 680x0 Sun SPARC RS/6000	Interactive Microport SCO RS/6000	SCO (binary) Others with source license	Intel Interactive SCO SCO Xenix HP-9000 RS/6000 Sun-3 Sun SPARC	Aviion Iris SCON/A Sun SPARC	N/A N/A N/A N/A
Run-time royalties	None	None	None	None	None	Yes. First 1000 free.	N/A
Curses	○	●[2]	●	●	●	○	N/A
X Window System	●	○	○	○	●	●	N/A
Motif	●	●[2]	○	○	○	●	N/A
Macintosh							
Version	N/A	3.00	N/A	N/A	N/A	N/A	N/A
Price	N/A	$1450	N/A	N/A	N/A	N/A	N/A
Price with source code	N/A	Not stated	N/A	N/A	N/A	N/A	N/A
Suported compilers	N/A	MPW C Think C	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A
Run-time royalties	N/A	None	N/A	N/A	N/A	N/A	N/A
System 7.0 features supported	N/A	Apple Events Multitasking communication 32-bit clean	N/A N/A	N/A N/A	N/A N/A	N/A N/A	N/A N/A

prototypers and code generators are readily accessible. Sample programs in popular books and magazines work in both environments. The disadvantages are also important. Not all Windows calls are necessarily implemented in the porting library. Programmers must be careful to use only functions that are available in both environments. The habit of hard-coding window coordinates must be broken since, for example, the coordinate (10, 100) has two totally different meanings in graphics mode and in character mode. (This is not really any disadvantage since you shouldn't be hard-coding this information.) Also, what you get is a Windows-style application. This is not what you want when moving to the Mac or a Unix graphical platform.

The most popular targets for porting the Windows API are DOS and Unix text modes. OS/2 text mode is also available, as is DOS graphics mode. Today, this approach represents an excellent choice for porting your application. It gains you immediate access to the millions of PCs on the market that are not running Windows. It also provides access to the Unix workstation market.

Subsets Are Fine

Suppose, instead, that you need to move your application across the broadest number of platforms possible. In this case, you may want to pick a product like XVT, which takes a greatest-common-denominator approach to portability. The common denominator typically does not provide the latest and greatest whiz-bang functionality, since it is not portable. What it does give is a solid basis on which to grow a portable application.

Since you will probably need to access those whiz-bang functions on particular platforms, make sure that you can sidestep the library and get right down to the operating environment. The fact remains, though, that the vast majority of applications simply do not need the latest and

Pros and Cons of Portable Libraries

CommonView3
PROS: Debugging classes; portable object memory management providing transparent virtual storage; snappy response on 16-MHz machine.
CONS: Multiple supporting DLLs can complicate installation process.

Mewel Window System
PROS: Fairly mature product with complete Windows API implementation, including extras like serial-port drivers; able to be used with third-party code and resource generators.
CONS: Text boxes don't act precisely as in Windows; requires special Mewel-only conditionally compiled code; third-party code generators need to have code adjusted; need to change from pixel to character coordinates; graphics mode very slow.

Panel Plus II
PROS: Ability to port previous code investments; no need to learn event-driven programming; applications look nearly identical in DOS and Windows.
CONS: Resulting program is not very Windows-like.

Windows.Txt
PROS: Windows API; compliance with code from third-party code generators; able to be used with third-party code and resource generators.
CONS: Need to change from pixel to character coordinates.

Wndx
PROS: Flexible, fine-grained control of user interface; ability to dynamically alter the user-interface style and create a unique interface; large assortment of support functions, such as macro recorders; portable resources and bit maps.
CONS: GUI standards must basically be re-created; large executable files.

XVT
PROS: Supports broadest array of platforms; only one to support the Mac; snappy response even on 16-MHz machine; portable resource design with native resource access.
CONS: Cutting and pasting text is slow.

zApp
PROS: Simplified interface to Windows.
CONS: No debugging or memory management classes; limited to Windows or Windows API products.

greatest features. Solid dependability is watchword one for the typical developer.

The primary advantage of this approach is the library's ability to translate a standard interface call into a native-mode function. Also, since native operating-system calls are used, updates to system resources (e.g., a new file-selection dialog box) are immediately available.

A disadvantage is that you cannot use commonly available features that are not present on all platforms. An exception to this appears to be the Windows-style MDI (Multiple Document Interface), which several packages emulate on all platforms. Also, you cannot use third-party tools written for a more general interface like Windows, although you may be able to use prototyping tools that generate resource files.

The World and More

But what if you're not satisfied with a subset; suppose you want all the functions a GUI designer has ever conceived? In that case, you'd probably want to consider an approach such as the one delivered by Wndx. The company's aim is to deliver full cross-platform functionality. If one platform has it, every other platform should have it, too.

This type of development library is constantly attempting to keep up with the latest and greatest changes. However, not only do you need to worry about bugs the operating system may have in implementing a particular function, you also need to be concerned about bugs the library may have introduced when implementing identical functions. Your programs will also tend to be much larger than those produced by the subset approach.

The Hidden Event Loop

We have seen the future, and it is driven by an event loop. But what about those tens of thousands of lines of code you've already created? You already have a successful product; you just want to move it over to a graphical interface, since that is where your clientele is moving.

Libraries such as Panel Plus II approach the problem from the code-maintenance point of view. Designed primarily as a data-entry interface, Panel Plus II presents the same procedural interface under both DOS and Windows. Roundhill has hidden the event loop deep in the library and presents only its standard data-entry interface.

The obvious advantage here is that you can quickly port your existing applications to Windows. The disadvantage? I'm not really sure. You probably don't want to write any new applications that don't take full advantage of an event-loop-driven architecture. Conversely, I have not seen many data-entry development libraries for Windows yet.

Shell Libraries

Shell libraries provide higher-level abstractions of basic user interfaces without offering a lot of added capabilities. For example, zApp simplifies the Windows environment by adding a set of C++ classes to the standard API. Shells are different from the other products reviewed here in that they are typically aimed at a single platform or at platforms that are very similar. The zApp product achieves its portability by distributing Magma's Mewel interface for DOS. Thus, the shell itself does not need to adapt to the changing environment.

In the following section, we look at seven products that take various approaches to portability. All of them provide code portability with Windows. DOS, OS/2 PM (Presentation Manager), and OSF/Motif are all typical target environments. Only one library, XVT, currently provides portability between Windows and the Mac. The suitability of any particular library rests, as always, in its ability to fit your own unique needs.

continued

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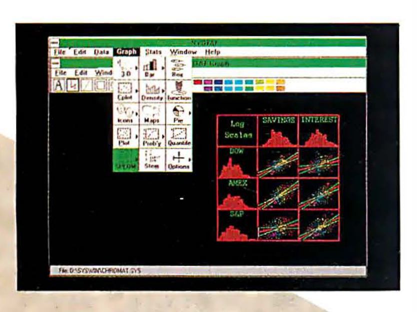
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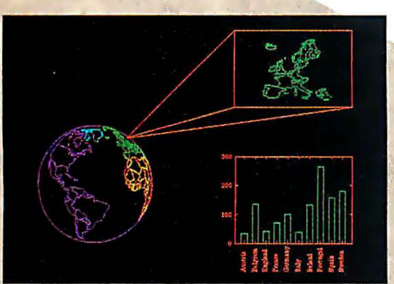
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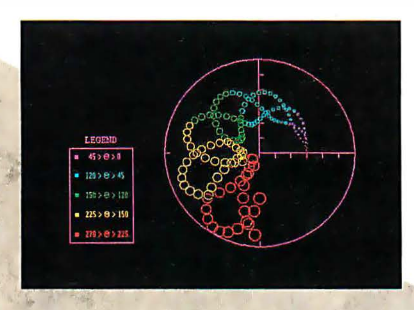
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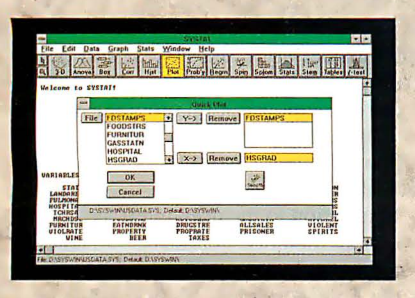
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BytePort Demonstration Program

BYTE asked each vendor participating in this review to develop a program called BytePort. BytePort is designed to demonstrate the portability provided by development libraries across multiple platforms. It exercises the portability of both text and graphics applications. Libraries that do not support graphics could therefore participate. Due to the wide disparity in library capabilities, the inability of a library to perform a specific function did not exclude it from the review. Thus, our review is limited by the functionality we asked to be implemented

BytePort is a simple program using multiple windows and a menu. The ability to open multiple windows (of all window types) is a plus. BytePort provides the following functions: view multiple textfiles, perform simple editing operations, perform simple data entry, view a graphics file, draw a simple graphics image, print any of the above, and provide platform-specific look and feel.

The text-file requirement was limited to 16 KB of ASCII text. The programs were expected to display and edit this information in a window without automatic text wrapping. Cut/Copy/Paste editing capabilities were required, as was the ability to enter new text. These functions were chosen to demonstrate capability rather than the vendor's ability to create a full-functioned text editor.

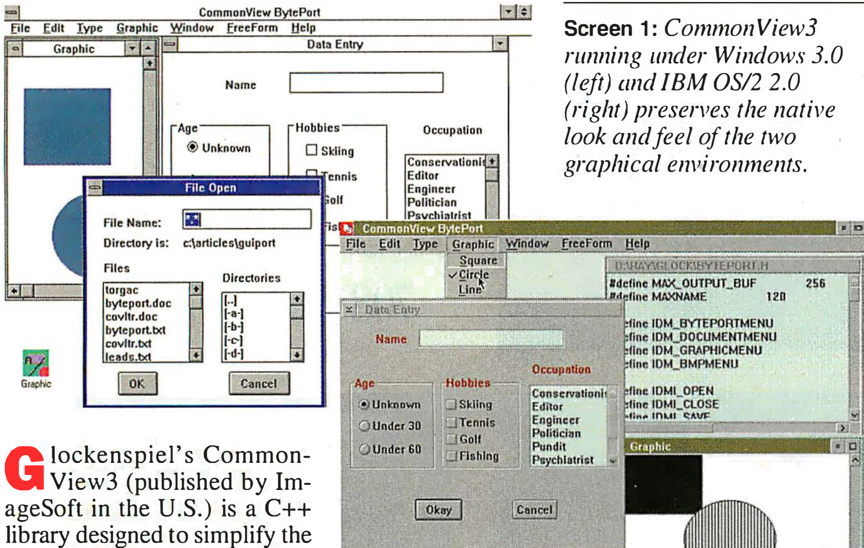
Also on the text-only side of the test is a demonstration of a window with standard control items: text field, check boxes, radio buttons, and pick lists. The application provides the ability to receive a person's name (text field), age (radio buttons), hobbies (check boxes), and occupation (pick list). Pressing an OK button displays a modal dialog box listing the values selected in the previous dialog box.

The graphics portion of the text consists of two windows. The first window allows lines, rectangles, and ellipses to be drawn. The particular shape to be drawn is selected from a text menu. There was no requirement to store the drawn image.

In addition to a drawing window, a bit-map window was also requested. This window allows the display of a native-format image (e.g., .BMP on Windows and PICT on the Mac) or a portable bit-map image (e.g., GIF or TIFF). Only a single bit-map style needed to be supported, since, again, this was a demonstration of ability and not of processing power or programmer capability.

The specification, executable file results, and source code for all the BytePort demonstration programs are available in electronic format. See page 5 for details.

CommonView3



Screen 1: *CommonView3 running under Windows 3.0 (left) and IBM OS/2 2.0 (right) preserves the native look and feel of the two graphical environments.*

Glockenspiel's CommonView3 (published by ImageSoft in the U.S.) is a C++ library designed to simplify the porting of applications among various GUIs. The CommonView3 library takes the greatest-common-denominator approach to portability, providing portable access to those capabilities that are found on all the supported platforms. The one notable exception to this is the MDI-style window. MDI windows are supported in both Windows and OS/2 PM (see screen 1). According to the documentation, support does not yet extend to Motif.

The term "greatest common denominator" does not imply minimal capabilities. As windowing operating systems mature, they are quickly increasing their capabilities in order to compete. Therefore, the greatest-common-denominator level is constantly rising. CommonView3 delivers the standard message and dialog boxes, bit maps (which are platform dependent), text editing, and list boxes. What you won't find are hierarchical menus or interprocess communication. Multiple threads under PM are supported. This was unique to the packages reviewed.

CommonView3 also adds some sophisticated capabilities such as being able to select multiple entries from a list box, spreadsheet-style list boxes, and object graphics. The graphics portion of the BytePort demonstration program was created using object graphics that provide full support for pen shading, colors, and object filling and hatching.

In addition to the user-interface library, two other included libraries aid in creating portable applications. The more important is the FreeStore class library, which provides a portable method of allocating memory across all supported platforms and implements virtual data storage on an object

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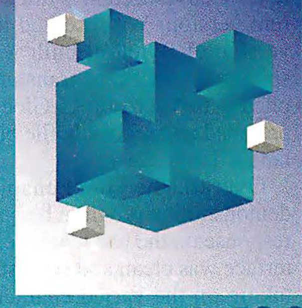
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basis. Although object storage will typically be allocated in main memory, this class library can also allocate space on disk. The switch from memory to disk storage is transparent to the application program. Of course, you will see a decrease in performance that is proportional to the speed and efficiency of the associated hard drives. A debugging class checks for problems, such as deleting the same object twice and using a previously deleted object.

The Container class library gives you a portable way to save, relate, and manipulate large numbers of objects. It is most useful for manipulating groups or lists of related objects. Typical subclasses include hash tables, arrays, keyed lists, rings, and trees. Any type of object can be stored, including other containers. In this way, hierarchical data structures can be easily developed and maintained.

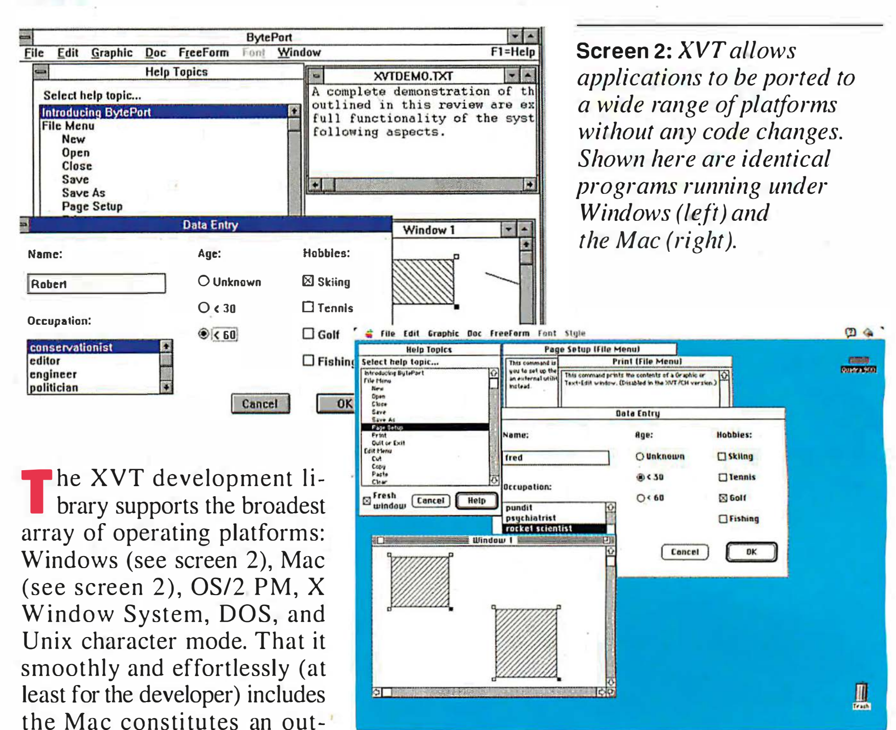
CommonView3 provides portable printer support for PostScript printers. The documentation states that it also works with Hewlett-Packard laser printers and may work with other printers. There is no explicit support for dot-matrix printers.

A set of CommonView3 DLLs needs to be distributed with your application. These provide the basic portability functionality, along with command dialog boxes, Clipboard support, help facilities, and so on. Delivering all the required DLLs along with the executable program still kept Glockenspiel's BytePort demonstration program in the moderate-size range.

Until recently, if you wanted to use CommonView, you also needed to purchase Glockenspiel's C++ CFront translator. This restriction is lifted with the current version. We received the Windows version of BytePort built with Glockenspiel's C++ CFront translator and compiled with Microsoft C. Glockenspiel also provided an executable file built with Borland's Turbo C++.

Overall, the Glockenspiel BytePort demonstration program had a very snappy response on the test machine. The user interface was clean and consistent, properly taking on the varied characteristics of a Windows and OS/2 PM environment. The source code was eminently readable and concise. The documentation shows how really simple it is to produce a windowing application with portability tossed in as an extra. The lack of a DOS version is a drawback, as is the need to carry around a pack of DLLs. Although advertising states that CommonView3 is available for Windows, OS/2 PM, NewWave, Motif, and the Mac, the company told me that as of May the Macintosh version did not yet exist.

XVT



Screen 2: *XVT allows applications to be ported to a wide range of platforms without any code changes. Shown here are identical programs running under Windows (left) and the Mac (right).*

The XVT development library supports the broadest array of operating platforms: Windows (see screen 2), Mac (see screen 2), OS/2 PM, X Window System, DOS, and Unix character mode. That it smoothly and effortlessly (at least for the developer) includes the Mac constitutes an outstanding feature.

The list of powerful capabilities is long. It starts with full support for standard abilities like dialog boxes, text fields, and text-editing windows. Portable graphics include lines, arcs, pie slices, and icons (i.e., bit maps). Although referenced in a portable manner, bit maps and icons are platform dependent—thus allowing you to use platform-specific development tools at the cost of total transportability. All graphics entities can be drawn as objects rather than bit maps. In the BytePort demonstration, the graphics objects can be selected, moved, and resized.

Standard resources such as menus, dialog boxes, and text strings can be referenced either portably, using the URL (Universal Resource Language) tool that comes with XVT, or nonportably using native resource compilers. Again, this lets you use third-party screen-prototyping tools on specific platforms. To aid portability, the URL tool even allows portable accelerator key definitions. For example, defining Alt/Left-arrow as an accelerator key sequence automatically maps to the Command/Left-arrow sequence on the Mac.

XVT even takes a stab at addressing the problem of font and font-style portability. By restricting an application's ability to set fonts and styles arbitrarily (i.e., all font requests must be made through menu selections), XVT manages to isolate the application from the differences in how fonts and styles are named in various environments.

One function family that is a major boon to portability has nothing to do with the user interface. XVT provides fully portable support for directory and file access. As anyone who has attempted to port code to the Mac knows, this is a major difficulty (just try to find the change directory command in Think C). XVT file and directory support includes saving and restoring current directories, changing directory paths, creating a list of all files in a directory, or limiting those files by type or name. Wildcard filenames are supported. The one missing function seems to be Make Directory, which does not appear to be supported.

Child windows, such as those contained in the Windows MDI, are completely portable. Memory management routines are also provided, along with debugging versions of these functions. Debuggable memory management routines will be very useful as you track those most elusive of all code problems. A portable help compiler and help program let you build your context-sensitive help once for all platforms. Since this feature does not use native help engines, you will still need to rebuild your help screens if you require total native look and feel.

The last feature worth mentioning is the ability to delve into the XVT library to access nonportable functions. For example, on the Mac, you can directly access the window handles and override the event loop. Overriding the event loop is very

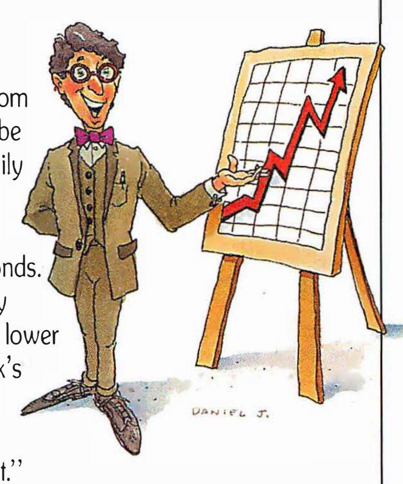
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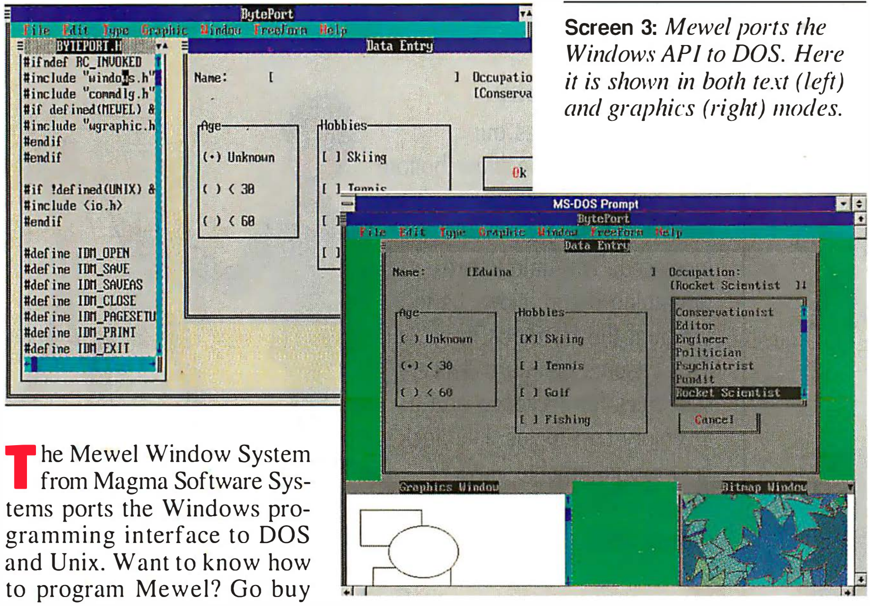
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important if you are using System 7.0 features, such as Apple Events, because the current XVT implementation does not support them. Similar features are available on other platforms.

XVT is not without its foibles. The particular problem I noticed was that cutting and pasting large text selections was rather slow. Lines of text are inserted individually rather than in a single chunk. XVT exhibits the same phenomenon when deleting text. You see a scrolling motion on the screen. Selecting a text area and pressing the Backspace key to delete it, however, doesn't invoke this behavior. This appears to be an area where XVT's internal code needs a closer link to the native platform.

XVT provides a powerful and flexible product across a broad spectrum of computing platforms. It is relatively expensive, but there are no run-time royalties. Although it is currently the only choice for complete portability among all these platforms, it is also the best choice.

Mewel Window System



Screen 3: *Mewel ports the Windows API to DOS. Here it is shown in both text (left) and graphics (right) modes.*

The Mewel Window System from Magma Software Systems ports the Windows programming interface to DOS and Unix. Want to know how to program Mewel? Go buy Charles Petzold's Windows manual, *Programming Windows*, 2d ed. (Microsoft, 1990; ISBN 1-55615-264-7). Many of the programming examples provided with Mewel are straight from his book. Want to use third-party code generators and automatic interface builders? Go right ahead. Many development tools now support the Mewel library.

The DOS, Unix, and OS/2 versions of Mewel have long supported text applications. Recently, Magma added the ability to create DOS graphics applications as well. You can build a single executable file to support both text and graphics displays. Your application can use command-line parameters or a simple auto-detect feature to determine the proper operating mode. The BytePort sample program uses a *g* on the command line to start graphics mode.

In text mode (see screen 3), Mewel provides a solid, snappy response even on a 16-MHz 386SX. This is important when considering support for older installed bases of computers not ideally suited for running today's computation-hungry Windows. Mewel has been on the market for several years and receives a steady stream of updates and improvements.

One difficulty with porting from straight Windows to Mewel is the change from pixel to character coordinates—Mewel thinks in terms of *x,y* column/row text screens. Although at first this appears to be a serious problem, it can be surmounted by intelligent use of the GetSystemMetrics and GetTextMetrics calls, which return such information as screen and text sizes. Not surprisingly, text happens to be 1 pixel wide by 1 pixel tall, and your screen is 80 by 24 pixels—not, perhaps, the largest screen to which you'll port your code. Conscientious use of these calls provides easy portability between Mewel and Windows and also lets you support a wide array of display sizes and resolutions.

The company claims that Mewel can perform any text-style operation that you can perform in Windows. Its biggest selling point is full compatibility with the Windows API. Magma also has a separately available toolbox set that contains, among other things, formatted data-entry classes, an interface to the Microsoft Help Advisor, a graphical mouse in text mode, a matrix control class, and a communications library. Full source code is available for all tools as well as the entire windowing system.

One difference I discovered with Mewel is the behavior of the insertion-point cursor when scrolling text areas. Clicking the down arrow on a text scroll bar moves the insertion point (and cursor) down a line. This is different from the Windows behavior, where the entire text area scrolls up a line and does not move the insertion point. Although not a major problem, it is an annoying difference, particularly when frequently switching between DOS and Windows applications.

Mewel attempts to move as many of the graphics primitives as possible over to the text-only world. For example, BytePort text mode can draw horizontal and vertical lines and boxes. Although these won't win you any design prizes (a drawing program in text mode simply doesn't work), the feature is very useful if you've used drawn lines to provide emphasis or sectioning in dialog boxes.

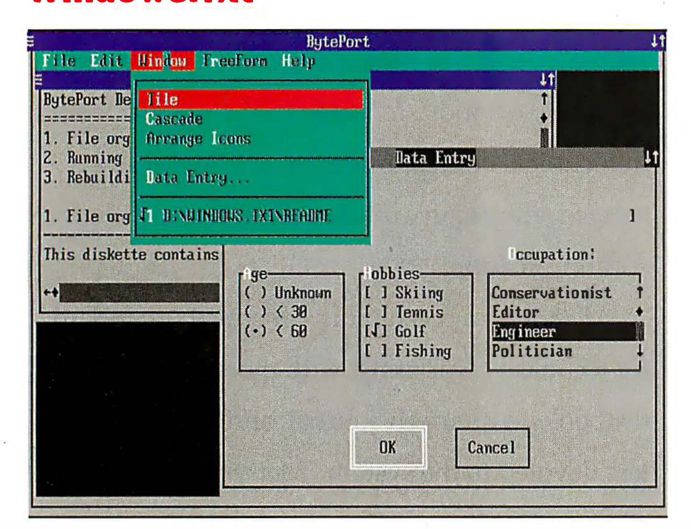
The BytePort demonstration uses standard Windows calls to open and initialize a printer device. Only text printing is supported at this time. The text version of Mewel appears stable and quick, but the newer graphics version (see screen 3) seems to have a way to go before I'd recommend it for general use. Little difficulties kept appearing in the demonstration program. In particular, pull-down menus would blink and then disappear if the mouse moved off the menu bar before the menu was fully displayed. Magma says that this is correct behavior and matches the action of Windows. Even so, I found it difficult to use the menuing system and repeatedly needed to reselect menus.

The menu problem is annoying, but speed is the overriding drawback. Magma claims that the problem comes from adding the graphics capability as a wrapper to existing compiler graphics libraries. Some Mewel users stay in text mode for most of the application and then dynamically switch to graphics mode to display a particular screen of information, thus mixing the speed of text mode with the flexibility of graphics output.

Mewel is an excellent choice when moving from the graphical environment of Windows to the text environments of DOS, Unix, and OS/2. The graphics mode comes free with the text mode, but I'd avoid using it except for special cases.

continued

Windows.Txt



Screen 4: *Windows.Txt ports the Windows API to DOS text mode.*

Windows.Txt from Interactive Engineering is an interface library with strong intentions of unseating Mewel as the text-based Windows API of choice. Interactive Engineering's goal is to provide transparent portability from Windows to DOS character modes.

The BytePort demonstration code the company delivered illustrates this portability nicely. The code was created using Blue Sky Software's WindowsMaker Professional, a popular screen-prototyping tool. The resulting code is used as is. There is no library-specific code added for Windows.Txt support. This ability is very important, since it means that you can receive direct support from third-party development tools without having to modify the code they generate. However, as with Mewel, the conversion from graphics to text coordinates takes some extra thought and careful planning.

Windows.Txt achieved a smooth and comfortable implementation of the BytePort program. All the text-editing windows were implemented as child windows of the main application window (i.e., the MDI). The data-entry and demonstration windows were created as separate primary windows, demonstrating full support for both models.

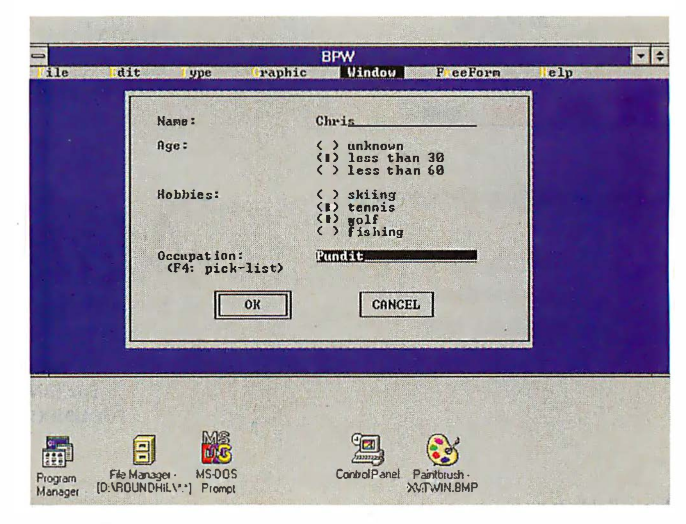
A subtle but important difference between Windows.Txt and the Mewel interface is the manner in which each handled text scrolling in the BytePort demonstration program. Clicking a scroll-bar arrow in Mewel moves the text-insertion point either a character horizontally or a line vertically. In Windows.Txt, the scroll-bar arrow moves the text displayed within the window; the insertion point remains fixed. The Windows.Txt behavior is identical to that of Windows (and the Mac and OS/2 PM, for that matter). The Mewel behavior catches you by surprise.

Windows.Txt comes with a very small user's guide, which presents an overview of the product and utilities. A series of appendixes provides a quick compatibility check between the real Windows 3.0 API calls and messages and this library. All nonsupported calls, typically graphics and multitasking, return reasonable error messages. Properly written code that conscientiously verifies error returns can operate with these calls without difficulty. Interactive Engineering also ships volumes 1 and 2 of the Microsoft Windows Programming Guides.

The text check (TCHK) utility examines your source code and generates a series of messages pinpointing calls and messages within your code that will function differently in the text-only mode. The standard system comes with an interface to the Help Advisor but does require the special Help Compiler available from Microsoft. In addition, you receive a dialog-box editor and resource compiler.

Windows.Txt is a definite contender for Mewel's dominance of the DOS Windows-style API arena. The programs are small and highly responsive. The attention devoted to small details (e.g., the text scrolling mentioned above) makes it more comfortable for users who are familiar with Windows.

Panel Plus II



Screen 5: *Panel Plus II provides a DOS-style programming environment, resulting in a DOS-style data-entry interface.*

Forget GUIs, standards, objects, and even event loops. Panel Plus II from Roundhill Computer Systems takes you away from all that. This package manages to port a DOS-style data-entry interface to Windows. Although my first reaction was that this is a silly thing to do, I soon realized that it made quite a bit of sense. Consider the following facts: (1) The DOS data-entry marketplace is fairly mature. People know the type of information they want to enter and display. Many applications in this market consist of "fill in the following form and save." Nothing fancy, just good, plain interfaces between the user and vast amounts of data. (2) Not everyone has become an instant Windows programmer overnight. (3) The customer is switching over to Windows. How soon can you deliver?

As you can see from screen 5, Panel Plus II will not win any beauty or style competitions under Windows. However, this window looks and acts exactly like the application running under DOS. Those familiar with the DOS application will not have to embark on a learning period to become functional under Windows. Even mouse support is identical. In the text-editing field, mouse movements appear to

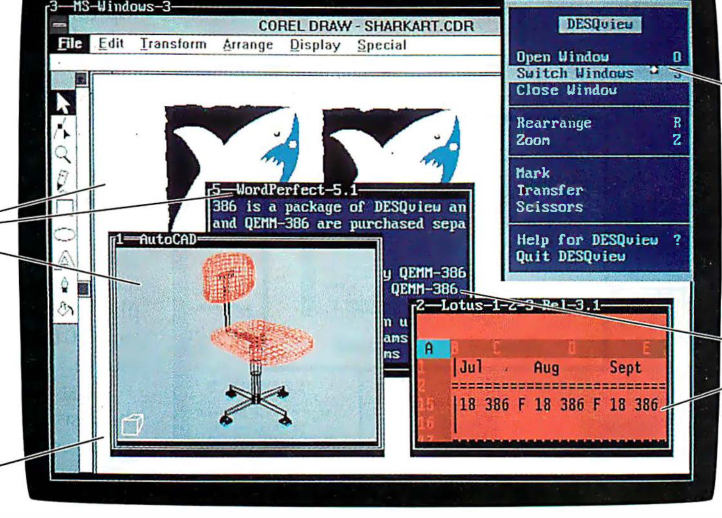
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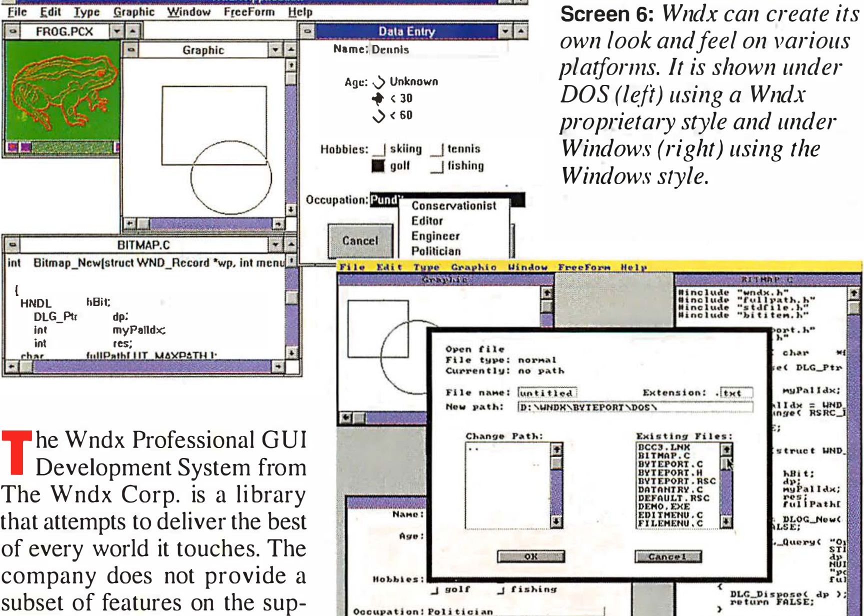
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translate into simulated arrow keys.

From the programmer's point of view, you never know you have left DOS. The event loop is completely hidden. Nowhere, in any of the code, is there a single Windows call. In short, there is no discernible difference between Panel's Windows and DOS programmer interfaces. You want data entry? You get data entry.

This approach may not be the wave of the future, but it definitely solves an immediate problem—how to move your current program and customers rapidly and efficiently to Windows while preserving your installed base of application code.

Wndx



Screen 6: *Wndx can create its own look and feel on various platforms. It is shown under DOS (left) using a Wndx proprietary style and under Windows (right) using the Windows style.*

The Wndx Professional GUI Development System from The Wndx Corp. is a library that attempts to deliver the best of every world it touches. The company does not provide a subset of features on the supported platforms. It supports all the features. If it exists in Windows, you can do it in DOS and Motif. Eventually, you will also have the capabilities of the Mac (I saw a very early beta version).

The Wndx approach to portability is unique. After writing your application using the supplied API, you attach a "style guide," which determines exactly how the user interface appears. The version I received had three style guides: Windows, Motif, and a proprietary Wndx style. Alternatively, these style guides can be applied dynamically at run time. Screen 6 shows the different styles applied to the BytePort demonstration program. The odd thing is that the standard style guide for Windows looks more like Motif than Windows. The company assured me that this is not an error. This is how the product ships. I do not understand this decision.

Although I doubt that you would actually want to change styles dynamically in the middle of a program, the basic premise is an interesting one. Wndx supplies the source code for all the styles, so you can create your own truly unique versions.

The difficulty with this approach is that Wndx is not using native operating-system toolboxes to build standard dialog boxes. It is building all of them itself. Everything is hand-drawn: dialog boxes, radio buttons, check boxes, scroll bars, and arrows. This introduces a tremendous amount of overhead.

Although it is impractical and meaningless to compare the executable code sizes of all the BytePort programs, it is significant that the Wndx library produced programs that were over 100 KB larger than the other BytePort demonstration programs. BytePort written directly to the Windows API generated executable file sizes of 30 to 50 KB. Other libraries generated sizes in the 180- to 200-KB range under Windows. Wndx clocked in with a 320-KB application. This size increases to over 400 KB in DOS, where Wndx links to the MetaWindow/Plus graphics interface and the Rational Systems DOS extender. Don't expect to produce even a moderately complex application without using this DOS extender. Given the size of the Windows code, the additional overhead required to operate as a stand-alone DOS application is surprisingly small.

Wndx builds all its own control items, and none of them, unfortunately, looks precisely correct. For example, the scroll bars are slightly different, and the scrolling arrows are shaped oddly. Of course, these problems can be fixed by altering the style guide, but most programmers probably want to spend their time developing code, not tweaking the interface. However, if careful control of your interface in multiple environments is important, Wndx gives you the ability to change everything.

User-interface issues aside, Wndx provides a wealth of tools that is astounding: machine-independent bit maps, a list manager, an error manager, and built-in desktop functions, such as a calculator and a calendar. Wndx is the only reviewed library to provide built-in macro recording and playback capabilities. These recordings can be stored in a machine-independent format. A unique feature related to macros is the ability to map an activity to a sequence of mouse and keyboard events. This triggering mechanism frees the programmer from having to keep track of potentially complex event sequences. A simplistic example is the ability to select a line of text if the user triple-clicks the mouse.

A list display manager supports spreadsheet-style lists in addition to the standard single-column list. A full set of manipulation routines allows the list to be loaded, edited, and sized dynamically. Building a spreadsheet-style application would be fairly simple.

Since everything else Wndx does is portable across all platforms, you should not be surprised to find that its resources are also portable. A Wndx-specific resource compiler produces machine-independent resource files that are then linked with your application. Typical resources include controls, default values, event handlers, menus, and window definitions. Platform-dependent font resources are also provided.

Wndx exhibits rather sluggish start-up performance under both DOS and Windows on a 16-MHz 386SX system. Under Windows, the main application window appears, and then the system snoozes for about 4 seconds before displaying the main menu. Once loaded, Wndx does display reasonable speed.

Wndx provides cross-platform uniformity at the cost of size and maintainability. If you're looking for tight, highly responsive code on lower-end systems, look elsewhere. If, however, you need fine control over your environment's appearance, Wndx is a library to consider. Wndx receives the highest marks for ambition.

continued

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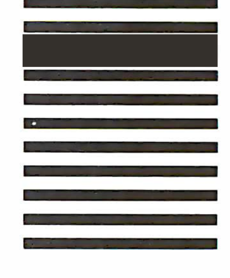
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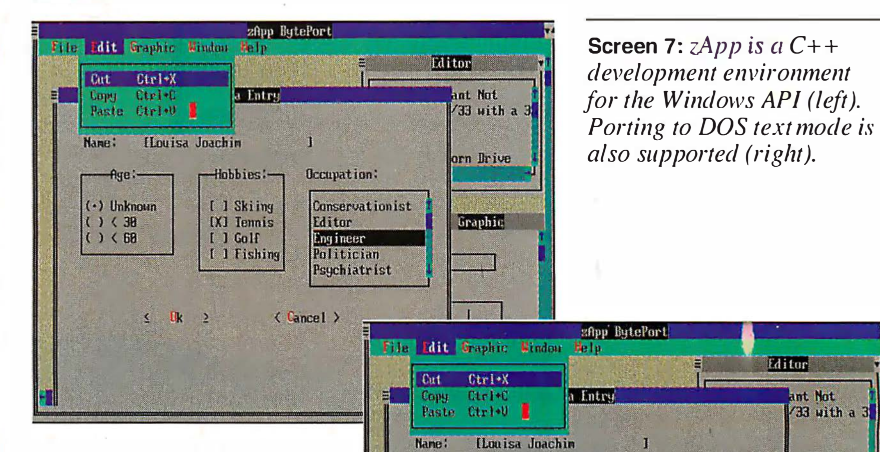
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zApp



Screen 7: *zApp is a C++ development environment for the Windows API (left). Porting to DOS text mode is also supported (right).*

Inmark Development's zApp is a shell-style library designed specifically for Windows. It achieves its portability to DOS text mode by distributing linkable copies of the Mewel library, which duplicates the Windows API. Minimal documentation on the Mewel interface library itself is included. All access is through zApp. Delivering on its promise of simplifying the Windows interface, zApp produced the smallest program listings for the BytePort demonstration program.

Since zApp is not designed to port applications off the PC/DOS environment, no attention is given to creating portable bit maps, data structures, and so on. The emphasis is strictly on developing Windows.

zApp provides classes that aid what I consider to be two of the most used functions in any computer program: text display and data entry. Most of what my applications do is put up small to medium-size portions of text, allow the user to modify them, and then store them away again, perhaps in a database. The zTextPane class handles the displaying and scrolling of text. Methods such as logToText and textToLog allow you to refer to textual information as rows and columns of text rather than having always to calculate the graphical point location at which a particular character starts. Currently, this ability comes at the price of being able to use only the fixed-pitch system font.

The zForm class provides the Windows-standard text fields, radio buttons, and check boxes. The text fields have been enhanced to provide basic formatted output and verified input. Through simple "picture" strings, you can limit the type of data that can be entered and also allow fields with embedded characters (e.g., the dashes in a social security number).

Since the shell gives you access only to basic capabilities, such functions as spreadsheet-style list boxes or multiple list box selections are not provided. Conversely, you get support for features like pop-up menus, arcs, and pixel depth mapping.

If you intend to stay within the DOS/Windows environment, zApp is worth a look. However, it does not offer any tools to help you port to more diverse platforms.

Recommendations

First, no matter which library you choose, plan to buy the source code. Then put it on the shelf and use it only for emergencies. Bugs will surface in almost any product, and since you are betting the company on these portability tools, it's a good idea to have the source code handy.

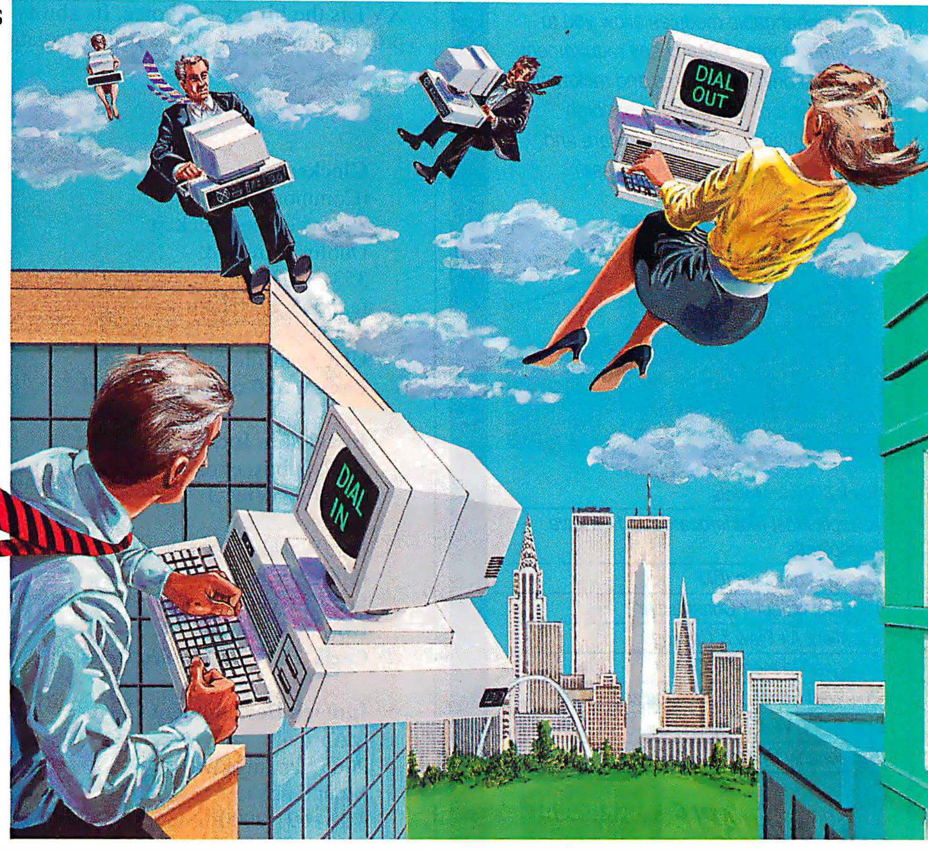
Second, get a demonstration program, including source code, from the vendor. Look over its approach to the problem. You can start by obtaining the sample BytePort programs that each company developed for the BYTE Lab.

Third, check out the level of technical support. In particular, look on BIX and CompuServe for support areas. Find out if a company has a support BBS. Public support forums are better than private BBS systems, since you are more likely to have other users on-line when you need them. It is possible to get support at 2:00 a.m.

Finally, determine exactly the level of support and functionality you require. If you want complete control over the look and feel of your application, a product like

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Wndx, with its extensive ancillary support, may be your best solution. Likewise, if you plan never to leave the DOS/Windows environment, an object library like zApp will simplify your programming chores.

However, if you intend your magnum opus for the masses, and the masses are spread from Windows to the Mac to DOS, XVT is the library of choice. Its ability to provide native look and feel while isolating the developer from conditional compilations is excellent. It's at the top of the list for my next programming project. ■

BYTE Lab editor Raymond GA Côté has extensive experience as a software developer and designer of interpretive languages and user interfaces. You can contact him on BIX as "rgacote" and on Internet at rgacote@bytepb.byte.com.

COMPANY INFORMATION

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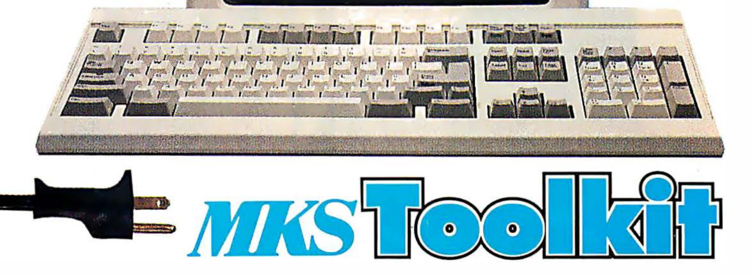
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Scanning the Spectrum

The BYTE Lab evaluates the performance of 24-bit color scanners for the PC and the Mac

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Color can grab your attention and tug at your emotions. Color images can make a presentation more effective, and a single color photograph can inject elegance into an otherwise plain brochure.

Color is compelling. That's reason enough to explore your options in scanners that can effortlessly transfer vivid images from paper to computer screen. The steady downturn in pricing makes the prospect of adding a color scanner to your collection of graphics and desktop publishing tools all the more attractive.

To judge how effectively today's 24-bit technicolor devices get the job done, this month's BYTE Lab Product Report reviews nine flatbed scanners for the Mac and PC: the Artix ArtiScan 6000C, AVR's 8000/CLX, the Epson ES-300C, the Hewlett-Packard ScanJet IIc, the Microtek ScanMaker 600Z, the Mirror 600 from Mirror Technologies, Mustek's MFS-6000CS, the UC630 from UMAX Technologies, and the Omnimedia 6C from X-Ray Scanner Corp. All are capable of delivering vibrant visuals to your desktop applications and offer a minimum resolution of 300 dots per inch. Although the nine products also are adept at scanning in text, black-and-white photos, and line art (images that lack the intermediate shades of gray typically found in black-and-white photos), we focus on their ability to handle artwork, rather than on their usefulness at performing OCR tasks.

What Price Color Image Processing?

Manipulating color images requires plenty of hardware muscle. To adequately display and edit color images, you need a monitor capable of reproducing a wide spectrum of color. For 24-bit color scanners, VGA color just doesn't cut it. At the very least, you need a screen that can display 256 colors. Color images also demand huge chunks of disk space. A 4- by 6-inch color photo, scanned in 24-bit color at a resolution of 300 dpi, can soak up over 12 MB of space on a hard disk. Likewise, color images can gobble up memory resources. And, on a machine with inadequate processing power, work on files containing color images slows to a crawl.

You also have to be prepared to make at least a relatively small capital outlay. Although the price of 24-bit color scanners has dipped over the last year, list prices still start at around $1300 and climb to around $3500 (see the table "Color Flatbed Scanners Compared" on page 234). The difference in price between a 24-bit color scanner and an 8-bit gray- scale scanner typically is about $400 or $500—a big enough gap to encourage you to carefully consider whether you really need color capability now or will need it in the future.

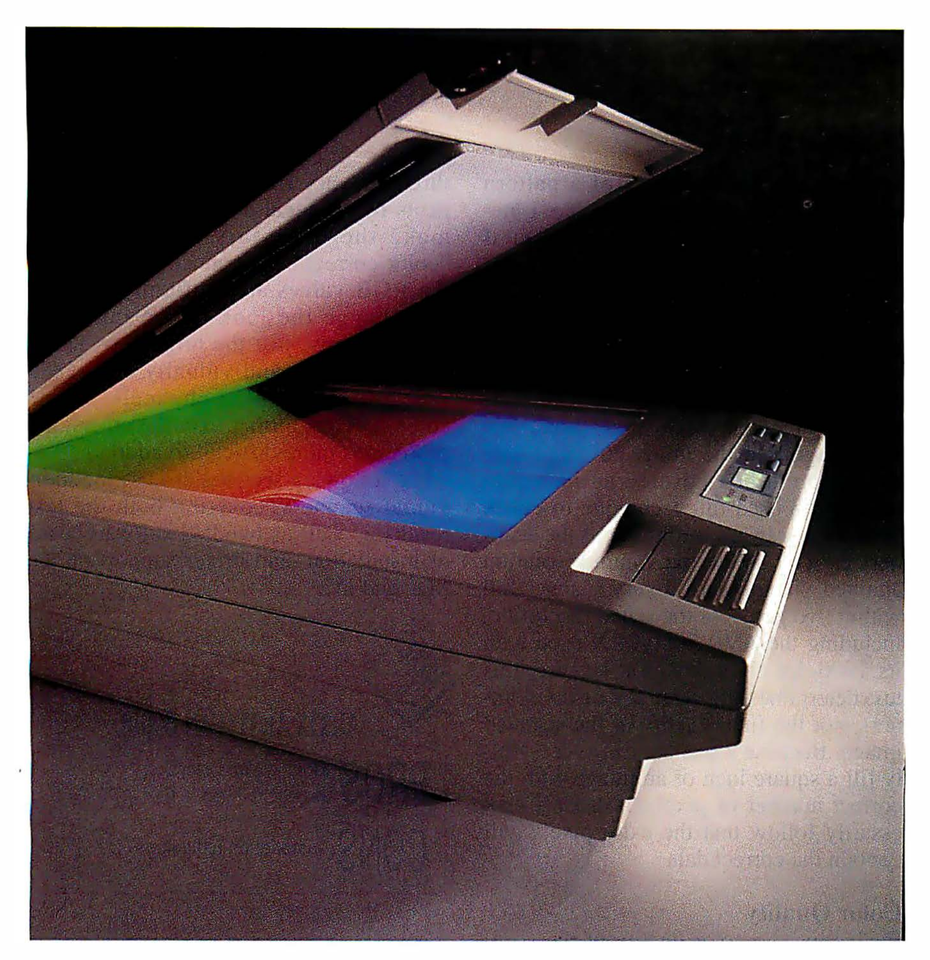
How to Build a Better Image

Whether they produce color or gray-scale images, flatbed scanners work similarly. As with a standard photocopier, you lay the hard copy—photograph, drawing, page of text—face down on a glass bed. A lighted bar, controlled by software, passes beneath the glass, reflecting light off the printed image onto a grid of photosensitive cells. The number of light sensors determines the actual (optical) horizontal resolution of the scanner. A scanner with a resolution of 300 dpi contains 300 sensors within a horizontal inch. Each pixel of the final image receives its data from a separate sensor.

Each light sensor transmits a signal corresponding to the brightness of the reflected light. That signal is converted to a digital value. In early scanners, each pixel held a single bit of data, so that each pixel was either on or off, black or white. In these scanners, each pixel can hold 8 bits of digital data, so each sensor can translate up to 256 levels of brightness.

As the light bar moves down the length of the scanned page, it collects image data. The precision with which the light bar travels determines vertical resolution. A scanner with a vertical resolution of 300 dpi can take 300 readings per inch. Some of the scanners we evaluated take readings at intervals of one six-hundredth of an inch, creating a scanned image with a true vertical resolution of 600 dpi.

Scanner vendors also devise software algorithms to enhance the resolution of the final image. This usually is accomplished by interpolation, a process by which a scanner's software adds pixels to the image, deriving a value for each additional pixel by taking an average reading of the pixels around it. Interpolation can double and, in some cases, quadruple the final resolution of the scanned image. The usefulness of this technique depends on the type of image you are scanning. You should not, for instance, use interpolation when



scanning line art or text because it makes both images and characters fuzzy. It can work well, however, for scanning black-and-white or color photographs.

Typically, 24-bit scanners offer different modes for handling different types of input. For gray-scale images, they take one 8-bit reading per pixel to derive 256 shades of gray. For color images, they take three 8-bit readings per pixel—one each for the three primary colors red, green, and blue—to re-create 16.8 million different colors. For line art, most scanners record a single bit for each pixel.

Color scanners collect the necessary red, green, and blue color readings in one of two ways. In a three-pass color scanner, the light bar makes three scans of the document. The first time through, the light passes through a red filter and records the red values of the image. The next two scans record the green and blue values. A one-pass color scanner flashes red, green, and blue light as the bar travels down the page, collecting all three values at once. In our tests, we found no significant relationship between the number of passes required and the quality of the scanned image. For an in-depth look inside scanners, see "How Scanners Work," in the June BYTE.

A Tidy Bundle

Resolution isn't the only factor to consider when you're in the market for a scanner. The scanning software bundled with the hardware can add significant value to your purchase. Adobe Photoshop is the premier image-editing program on the Macintosh. Most Mac scanner packages include either a full-fledged version of the product or a "lite" edition that lacks some of the higher-end image processing functions. You also should look for a "plug-in" software module that lets you scan images directly into Photoshop.

Among the Mac scanners reviewed here, the Mustek MFS-6000CS and the HP ScanJet IIc do not ship with a version of Photoshop. The IIc also lacks a Photoshop plug-in. HP ships DeskScan and DeskPaint for the Mac; Mustek supplies Color It, a highly capable 24-bit paint program with a built-in scanner module (see "Art for Business's Sake" in the April BYTE for a closer look at Color It). Despite the strengths of other applications, any replacement for Photoshop is suspect. An outstanding image editor, it is highly regarded among graphic designers and desktop publishing professionals.

The software decision is not so clear-cut on the PC side. Two image editors share the spotlight: PhotoStyler, a powerful image editor developed by ULead and now owned by Aldus, and Picture Publisher from Micrografx. Version 3.0, the latest release of the latter program, adds many exciting new features. Either of the two will satisfy most users, but the trimmed-down edition of Picture Publisher, Picture Publisher LE (the *LE* stands for *limited edition*), lacks some important high-end features, such as the ability to do color separations and mask out certain areas of an image. HP bundles DeskScan

BYTE ACTION SUMMARY

- **WHAT 24-BIT COLOR SCANNERS DO**
  These scanners let you scan vivid images, in 16.8 million colors into your computer and onto your monitor screen. You can produce black-and-white images with 256 levels of gray and standard line-art images as well.

- **LIKES**
  All these scanners produce high-quality color output. Prices have dropped significantly over the past year.

- **DISLIKES**
  Some of the scanners are very slow on color jobs. Color images also take up huge amounts of disk space.

- **RECOMMENDATIONS**
  We like the Microtek ScanMaker for its nice blend of features, image quality, and price. The low-cost Epson ES-300C produces great scans but is very slow. The Mirror 600 is our top pick on the Macintosh platform.

PHOTOGRAPHY: SCOTT PARKER / AVIS STUDIO © 1992

for Windows with its color scanner for the PC. This choice is less problematic on the PC than on the Macintosh, because most PC-based image editors include drivers for the ScanJet.

Putting Scanners to the Test

To limit the impact of software variations and the like on our test results, we did our best to follow consistent testing methods. On the PC platform, each scanner was connected to a 486-based EISA system with 8 MB of RAM. The display system included a Hercules Graphics Station Gold 16+2 board hooked to a 16-inch Sony Trinitron Multiscan HG monitor. Each scanner came with its own interface card. In most cases, we scanned the samples from within Aldus PhotoStyler 1.1a. The AVR 8000/CLX lacked a PhotoStyler driver, so we used Picture Publisher 3.0 to test it. We started timing as soon as the scan operation was triggered from software and ended each test when the entire image appeared on screen.

We ran the Mac tests on a Macintosh II with a 40-MHz Radius Rocket accelerator, 8 MB of RAM, a Direct Color/24 display card, and a 24-bit Radius dual-page display system. We scanned the test pages from within Photoshop 2.01, using plug-in modules supplied by the scanner vendors. Only the HP ScanJet IIc lacked a Photoshop plug-in, which forced us to use HP's DeskScan II software. Two of the Photoshop plug-ins—the ones bundled with the Mustek MFS-6000CS and the XRS Omnimedia 6C—did not support line-art mode. For those models, we scanned line art in gray-scale mode. In all cases, we used the scanners' default settings during testing.

Our main objectives were judging the quality of each unit's scanned images and its scanning speed (see figure 1). Because most scanners operate differently in different modes, we focused our efforts on testing performance in three basic modes: gray scale, line art, and color. (See the test target on the next page.)

An 8- by 10-inch black-and-white photograph measured the gray-scale performance of the scanners. We also used the Kodak Gray Scale test, a strip showing 20 gradations of gray. The fancy page of text we used to discern line-art quality included type sizes ranging from 6 points to 24 points and a wide assortment of serif and sans serif typefaces. We also scanned the patterns composing the MicroCopy Resolution Test Chart from the National Bureau of Standards. Each pattern consists of five equally spaced horizontal and vertical bars that intersect to form an L shape (see the tests on the next page). The space between the bars gets progressively smaller with each pattern. After scanning in the chart, we noted when the five bars of a pattern were no longer clearly discernible. Line-art performance is especially important if you plan to do extensive OCR work.

To check each scanner's accuracy, we simply scanned a ruler. Using image-editing software, we selected an area equivalent to the scanner's resolution. For images scanned at 600 dpi, for example, we selected a 600-pixel area. We then magnified the image to make sure the selection box covered an inch precisely. We used this technique to check both the hardware resolution of the scanners as well as the maximum resolution attained via software. Every scanner fell within two pixels of the stated resolution, including the AVR 8000/CLX used with its 1600-dpi algorithm. But beware, this test determines the accuracy of the scanners, not the final quality of the scanned image. Because a scanner can successfully fill a square inch of an image with the correct number of pixels, it doesn't necessarily follow that the extra pixels will contain the correct data.

Color Quality

Evaluating the color quality of the scanners is a trickier business. We started with a color rendition chart from Macbeth, a division of Kollmorgen Instruments Corp. The 24 colors in this grid represent natural objects such as human skin, blue sky, and foliage, with each color having a specific CIE value. The CIE (Commission Internationale de l'Eclairage) is a widely accepted international standard for specifying objective, device-independent color. Kevin Draz of Tektronix, Inc., one of the leading companies in color research and the manufacture of output devices, converted the chart's CIE values to CMYK values using an algorithm developed by the company. He then converted the CMYK values to RGB values so that we could measure how well the test scanners did at converting color images on paper to on-screen color images.

We scanned the Macbeth Color Checker Chart into Picture Publisher 3.0 and took an average RGB reading of each color swatch. The graph in figure 2 depicts the color variance of each scanner compared to the converted CIE values. The longer the bar, the better the color conformed to the control value shown in the Macbeth chart. The red bar indicates how well a particular scanner handles the red component of a color, the green one tracks a scanner's ability to represent green, and the blue bar depicts the accuracy achieved in duplicating the blue component.

Also significant is the amount of deviation among the three color bars. If the three all vary from the control components by an equal amount, it is easier to make the necessary adjustments to "color-correct" the scanned image. When the RGB values are uniformly off, you can change the look of the image by adjusting, say, just the brightness, rather than having to individually adjust the red, green, and blue channels. If one color deviates further than the others, the problem is more difficult to address.

The following sections discuss the individual scanners, covering both the test results as well as bundled software, ease of installation, and driver support on the Mac and PC.



ARTIX ARTISCAN 6000C

Artix's ArtiScan 6000C comes with one of the most technically advanced image processing packages offered for the scanners we tested, ColorShop 24 for the PC. (Artix has a Mac-compatible scanner but could not send us one in time for testing.) ColorShop 24 lets you print reproduction-quality line art and halftones (images that use dots to reproduce shades of gray) on laser printers.

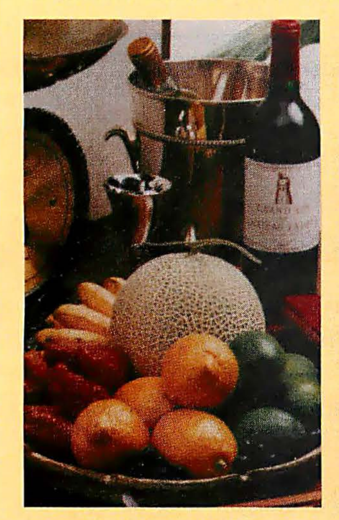
The ArtiScan 6000C's speed test results are average. Scanning a black-and-white photo produces an image with very good contrast, and the gray-scale scan was excellent. Only two other scanners besides the ArtiScan 6000C, the Microtek ScanMaker 600Z and the UMAX UC630, proved capable of reproducing all 20 shades in the Kodak Gray Scale test. The result of the 24-bit color scan test of the Macbeth chart was one of the best of the eight scans done on the PC, save for a few imbalances in the oranges and yellows.

The ArtiScan comes with Picture Publisher LE and Recognita Plus OCR software. In addition, Artix offers an add-on called the ArtiScan Slide Scan Kit for making high-quality scans (with resolutions as high as 800 dpi) of slides, film, x-rays, and transparencies.

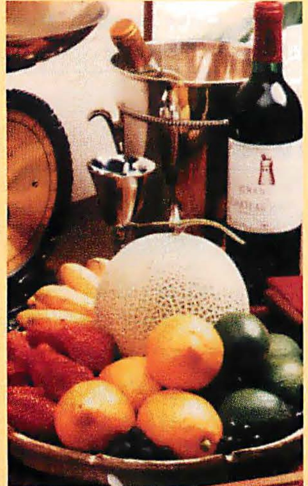
Installation is the product's one hitch. The SCSI card was almost impossible to install in the PC, because of a miscalculation in the placement of the port connec-

COMPARISON OF COLOR SCANS

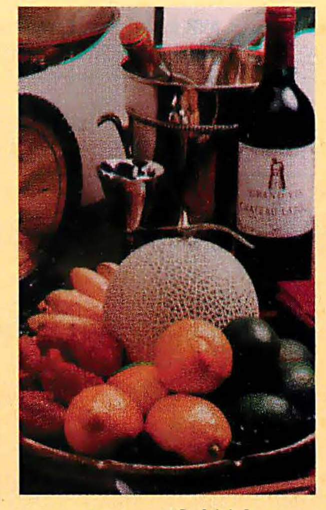
The reproductions below show sample color scans from each scanner in this report. The scanned photo tested each unit's ability to reproduce colors, shades, and hues. The MicroCopy Resolution Test Chart, from the National Bureau of Standards, exercises a scanner's line-art abilities.



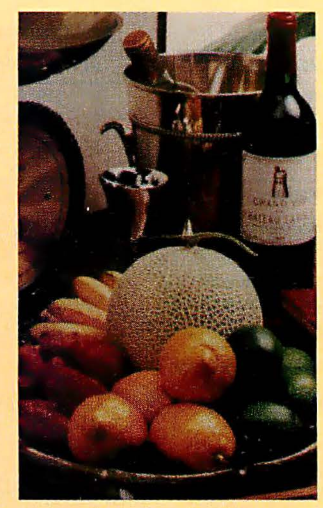
ArtiScan 6000C



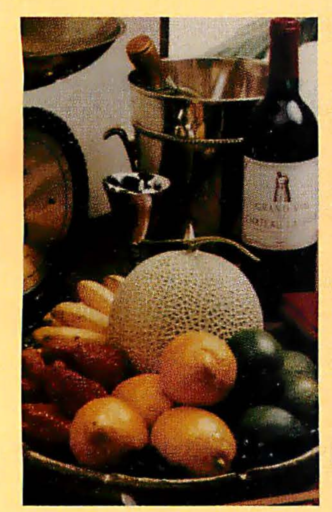
AVR 8000/CLX



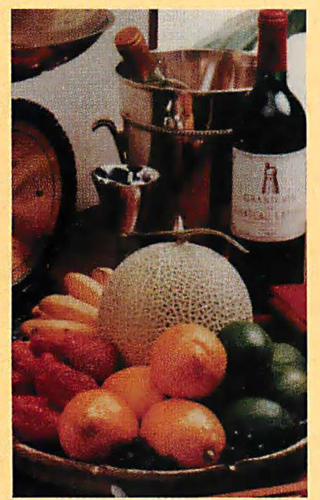
Epson ES-300C



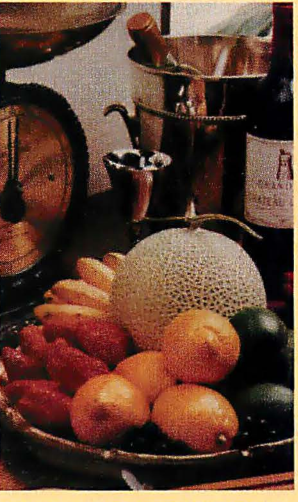
HP ScanJet IIc



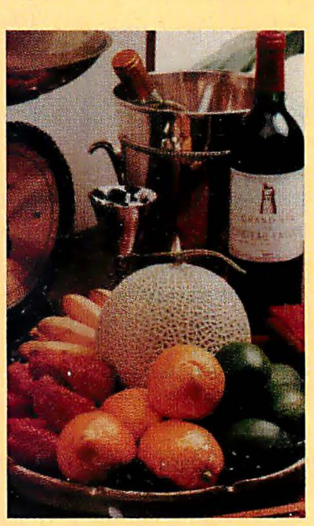
Microtek ScanMaker 600Z



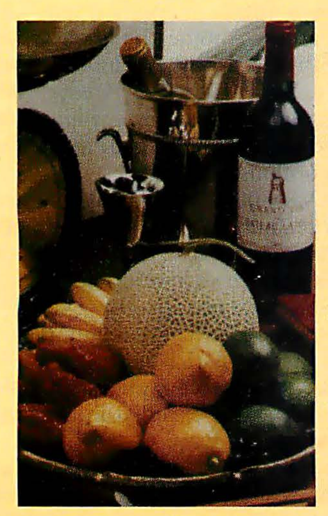
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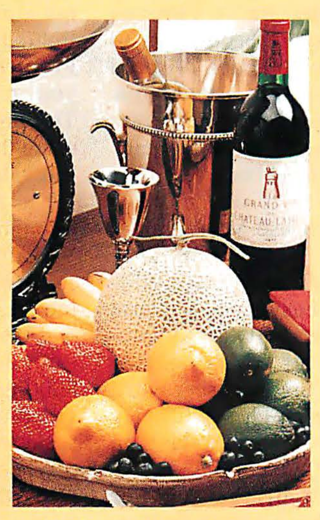
Mustek MFS-6000CS



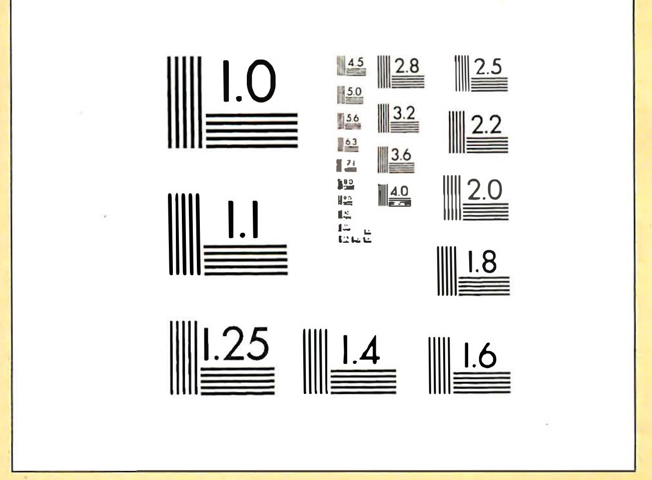
UMAX UC630



XRS Omnimedia 6C



Original photo, separated by traditional methods



MicroCopy Resolution Test Chart

PHOTOGRAPH SUPPLIED BY FUJI PHOTO FILM

COLOR FLATBED SCANNERS COMPARED

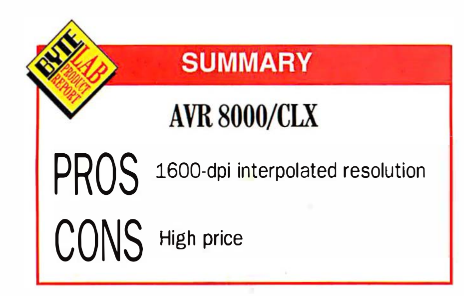
Software bundles can add significant value to your scanner purchase. HP ScanJet emulation will ensure software support on the PC platform while Apple scanner emulation will hedge your bets on the Mac side. (• = yes, ○ = no, N/A = not applicable.)

Company	Artix Technologies	AVR, Inc.	Epson America, Inc.	Hewlett-Packard Co.	Microtek Lab, Inc.	Mirror Technologies	Mustek, Inc.
Model	ArtiScan 6000C	8000 /CLX	ES-300C	ScanJet IIc	ScanMaker 600Z	Mirror 600	MFS-6000CS
Price	$1950	$2190	$1399 DOS interface kit: $495 Mac interface kit: $595	Mac: $1995 PC: $2195	$1995	$1299	Mac: $1895 PC: $1295
Platform	Mac*, PC	Mac, PC, PS/2	Mac, PC	Mac, PC	Mac, PC	Mac	Mac, PC
Hardware resolution (H x V)	300 dpi x 600 dpi	400 dpi x 400 dpi	300 dpi x 300 dpi	400 dpi x 400 dpi	300 dpi x 300 dpi	600 dpi x 300 dpi	300 dpi x 300 dpi
Max. resolution with software (H x V)	600 dpi x 600 dpi	1600 dpi x 1600 dpi	600 dpi x 600 dpi	800 dpi x 800 dpi	600 dpi x 600 dpi	600 dpi x 600 dpi	600 dpi x 600 dpi
Scanning method	3-pass	3-pass	1-pass	1-pass	3-pass	3-pass	3-pass
Maximum document size	8.5" x 11.7"	8.5" x 14"	8.5" x 11.67"	8.5" x 14"	8.5" x 13.5"	8.5" x 14"	8.5" x 13.5"
Dimensions (L x W x H)	18.5" x 13" x 5"	21.3" x 12.9" x 4.55"	20.1" x 12.6" x 4.8"	23" x 14.5" x 4.5"	20.2" x 13.5" x 4.6"	21" x 13.4" x 5"	20.2" x 13.5" x 4.6"
Weight	17.5 lbs.	15 lbs.	19.8 lbs.	29.5 lbs.	19.58 lbs.	18 lbs.	19.58 lbs.
Bundled software (PC)	ColorShop PhotoStyler 1.1a Recognita Plus OCR	Picture Publisher LE EasyScan	Micrografx Windows Draw Picture Publisher LE	DeskScan II (includes ZSoft's PhotoFinish)	PhotoStyler 1.03	N/A	Picture Publisher LE Perceive OCR
Bundled software (Mac)	Photoshop 2.01 (and plug-in) ColorShop	Photoshop 2.0 (w/ Scantastic Plug-In Module) EasyScan	Photoshop LE (and plug-in) Acquire	DeskScan II (includes Zedcor's DeskPaint) Scanmatch color calibration	Photoshop 2.0 (and plug-in) Mirrorscan	Photoshop 2.0 (and plug-in)	Color It UMAX Scan OCR
Color preview	○	•	•	•	•	○	•
Zoom preview	○	○	○	•	○	○	○
Optional transparency scanner/price	$695	○	○	○	○	○**	○
Optional sheet feeder/price	○	$795	○	$695	$699	○**	○
HP ScanJet emulation	○	•	○	•	○	N/A	○
Apple scanner emulation	•	•	•	○	○	•	○
Warranty	1 year	2 years	1 year	1 year	1 year	1 year	1 year

*Mac-compatible model is available but was not tested.
**Add-on is under development.

tor on the board. Brute force prevailed, however, and we managed to move on to trying to follow the sketchy instructions for installing the Picture Publisher driver.

This little-known scanner undoubtedly will carve a niche for itself in the image editing, desktop publishing, and graphics marketplace. Keep your eye on it.



AVR 8000/CLX

Advanced Vision Research's 8000/CLX has a base optical resolution of 400 dpi horizontally and vertically, but it can generate an effective resolution of up to 1600 dpi using interpolation or replication. The scanner driver for Picture Publisher for Windows handles interpolation differently than most other scanners. If you select a scanning resolution higher than the 400-dpi optical resolution of the scanner, you can choose between speed 4, which uses interpolation to enhance resolution to 1600-dpi, or speed 5, which uses replication (a technique that enhances resolution by creating pixels and filling each new pixel with image information from its neighbor).

You can choose to use AVR's EasyScan software or use Micrografx's Picture Publisher. Picture Publisher provides more all-purpose image editing functions than EasyScan. Because our choice for testing software, PhotoStyler, doesn't offer AVR scanner drivers, we used Picture Publisher when testing this scanner. This partially accounts for the unit's poor showing on the color speed test.

The Mac version of the scanner includes a stripped-down edition of Photoshop and a plug-in for scanning directly from Photoshop. The plug-in works in the same way as AVR's DA (desk accessory), letting you choose color, gray-scale, halftone, and line-art modes. It even includes a nice selection of halftone patterns and options for doing gamma correction, a technique used for bringing out shadow details or toning down highlighted areas. Another bundled utility, PicturePress, comes in handy when you're dealing with large image files. The program compresses graphics files using the standard JPEG or JPEG+ "lossless" algorithms.

The AVR 8000/CLX dawdled its way through scanning the Grumbacher Color Visualizer Chart in 17 minutes and 18 seconds, the slowest result for any of the PC-based scanners. However, this was the only scanner tested with Picture Publisher. With the Mac, the AVR 8000/CLX performed well on the color speed tests, and it excelled in the gray-scale and line-art tests.

When we scanned in the Macbeth chart using the scanner's default settings, the darker hues were not as faithfully scanned as the lighter hues. But with some adjustments in the contrast and brightness settings, we managed to bring

UMAX Technologies, Inc.	X-Ray Scanner Corp.
UC630	Omnimedia 6C
$1995	$3500
Mac, PC	Mac, PC, Sun, Next
300 dpi x 600 dpi	300 dpi x 600 dpi
600 dpi x 600 dpi	600 dpi x 600 dpi
3-pass	3-pass
8.5" x 14"	8.5" x 13.5"
21" x 13.4" x 5"	20.2" x 13.5" x 4.6"
18 lbs.	19.58 lbs.
ImageIn Color Professional MicroArt II	PhotoStyler 1.0
Photoshop 2.0 (and plug-in) Scanmatch color calibration	Photoshop 2.0 (and plug-in)
○	•
○	•
$895	•
$495	$699
•	○
•	○
1 year	1 year

the colors very close to the original hue and saturation levels.

All in all, the AVR produces acceptable scans of a variety of original printed materials but, at $2190, it is one of the highest-priced scanners we looked at. For certain users, the investment may be worthwhile. That price gets you an interpolated resolution of 1600 dpi, the highest of any scanner in this group.



EPSON ES-300C

The Epson ES-300C is a 24-bit color scanner that is very competent at scanning everything from detailed black-and-white line art to complex color images. In its 8-bit gray-scale mode, it produces images in 256 shades of gray. Capable of achieving a resolution of 300 dpi both horizontally and vertically through hardware, the Epson can reach 600-dpi resolution through software interpolation.

The one-pass ES-300C produced some excellent scans during our tests—particularly with color photographs. In some cases, the scanned image display looked even better than the original, showing excellent color balance, contrast, and hue. Another nicety is the device's ability to make color corrections during scanning so that you can match the output of printers and monitors.

On the PC, test results for the Epson ES-300C were impressive for resolution but disappointing in the speed department. Among those scanners using PhotoStyler, the Epson ranked at the bottom on both the color chart and black-and-white photo speed tests. Only the Artix ArtiScan finished lower on the text speed test—just 11 seconds after the ES-300C.

A gray-scale scan of the test black-and-white photo done at 300 dpi produced a very good scanned image, with some loss of detail in the darker, shadowed areas of the original. This was typical of the results of most gray-scale scans done using PhotoStyler on the PC, however.

Our 600-dpi test scan of various fonts faithfully reproduced the quality of the original, which was done on a laser printer. The scan even picked up specks of stray ink created during the printing process. Scanning the MicroCopy Resolution Test Chart also produced impressive test results.

PhotoStyler offers greater flexibility than Picture Publisher LE. PhotoStyler lets you select one of 19 scanning output resolutions, from 50 dpi to 600 dpi. If you simply plan to display your images on-screen, you can choose a lower number to match the resolution of your screen. If you want to output an image to a laser printer, a higher resolution is required, most commonly 300 dpi.

In addition to Picture Publisher LE, the scanner's DOS interface kit ($495) includes a bidirectional parallel interface board, Epson DOS device driver, parallel cable, and Windows Draw (Micrografx's easy-to-use drawing program). Setup is simple, and if you already have installed Picture Publisher or PhotoStyler under Windows (the scanner may be controlled by either program), you could be scanning your first images in minutes.

On the Mac, as on the PC, the Epson was the slowest at scanning a color image. The well-stuffed Mac package includes a SCSI interface board and cable, Epson Apple scanner driver, Second Glance's Scantastic Photoshop plug-in module for access to Photoshop, the Acquire DA, and Adobe Photoshop LE.

In both the PC and Mac forms, the ES-300C uses single-pass technology for color scanning, turning on its red, blue, and green fluorescent lights in sequence. During a monochrome scan, all three colors light up simultaneously.

On the PC, the control panel lets you enlarge or reduce the image size from 200 percent to 50 percent when outputting directly to a printer. You'll also find a brightness control to set one of seven levels for scanning faint originals, line art or text, or dark originals.

Aside from its poor results on the speed test, the Epson ES-300C produces very fine results, and we recommend it for scanning any type of material, especially color images.



HEWLETT-PACKARD SCANJET IIC

For many, Hewlett-Packard means reliability and performance, and those characteristics carry over to the fast ScanJet IIc. The hardware's optical resolution is 400 dpi, but with the accompanying control software, you can boost resolution to 1600 dpi. Scanning is carried out in a single pass of the twin fluorescent scanning heads. Light reflected from the scanned material is picked up by a charge-coupled device and transmitted in 4-bit, 8-bit, or 24-bit mode.

Macintosh setup is a breeze. You can install the DeskScan application and the DA in one simple step. A terminator fits between the scanner and interface cable, and you set the SCSI ID from a rotary switch at the rear of the scanner. Because the ScanJet IIc lacks a Photoshop plug-in module, you must use DeskScan. Performance suffers because DeskScan must write the scanned image to a disk file instead of displaying directly on the screen.

continued

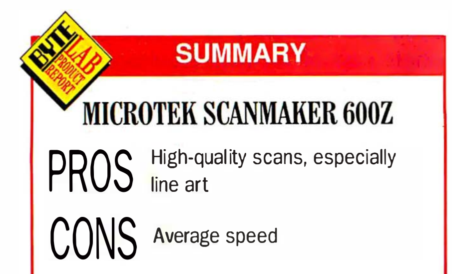
The PC package comes with DeskScan II software, a SCSI interface card, cables, and terminator. As with the installation of many PC scanners, the ScanJet IIc modifies your CONFIG.SYS and WIN.INI files automatically. (On our test PC, this changed the configuration of Windows' icons and the size of its main screen.) Hewlett-Packard is astute enough, however, to include a section on installing the scanner on EISA systems, which none of the other scanner companies even mention in their manuals.

Among the ScanJet IIc's image processing options are dithering (simulating grays by turning pixels on and off), thresholding (eliminating gray-scale information from a scan), color correction, gamma adjustment, mirroring, data inversion, and filtering.

What the ScanJet IIc offers in speed is offset by the quality of its scanned images. The scans, while adequate, are nothing to rave about. For the most part, the scans of chips in the Macbeth Color Checker Chart appear darker than the original chips.

HP just started offering a new version of DeskScan (1.51) that's TWAIN compliant. This means users will be able to activate the scanning procedure from within any application—desktop publisher, word processor, whatever—that complies with the TWAIN specification. (TWAIN, basically, provides a programming interface that lets applications use one set of device drivers for talking to compliant peripherals, such as scanners.)

The ScanJet IIc is a well-built machine. Hooked to a PC, it's very fast at scanning color. Hooked to a Mac, it's a midrange performer. The sheet-feeder option makes it a strong candidate for OCR work. Because it's from HP, you can count on quality components and—on the PC side—strong software support. If speed is your main criterion for buying a scanner, put the ScanJet IIc on your list.



MICROTEK 600Z

Microtek's 600Z color scanner is especially well-suited for OCR tasks. We clocked good times on the line-art tests, and the line-art resolution results also were good. Even more significant, is the optional 100-page sheet feeder that would permit the machine to take on heavy-duty OCR jobs.

On the PC, the ScanMaker 600Z proved to be a winner in all the tests for quality. The scanned black-and-white photo was very clear, showing detail in even the darkest areas. Because of snafus with the Picture Publisher driver, we had to use PhotoStyler to bring in the Macbeth chart. The hues were very close to those in the original chart.

Scanning our test page of different type sizes and styles at 600 dpi also produced excellent results. The detail and precision evident when the scanned image is magnified place this scanner in the upper ranks for quality black-and-white scanning. The Kodak Gray Scale scan looked equally stunning, clearly showing all 20 gradations.

Strong software support distinguishes the ScanMaker 600Z. The Macintosh bundle includes the Scanmatch color calibration program, a useful utility for enhancing the quality of your color scans. Developed by Savitar, Inc., Scanmatch color-corrects the image on your monitor so that it matches the scanned image. (The software uses Tektronix's TekColor device files to "know" about the monitor hooked to your Mac.) Microtek's Photoshop plug-in is the best of the bunch. The driver can display a color preview, and a scrollable zoom tool lets you check the fine detail before doing the final scan. You use slider bars to set resolution and scaling values, and you can adjust brightness and contrast for each of the three RGB channels.

ScanMaker 600Z also has tools for fine-tuning the brightness in the shadow, midtone, and highlight ranges. The Display Matching system supplies precalibrated settings for popular Mac monitors. Microtek also bundles its impressive DA for fast and convenient scanning.

Microtek includes the original ULead version of PhotoStyler with its scanners. And because of Microtek's strong presence in the scanner market, many vendors of PC software offer software drivers for the ScanMaker 600Z.

Installation is simple on both platforms. The PC requires Microtek's MS-PCY interface board, which comes with the unit. You can change the hardware address using DIP switches if the default settings cause a conflict. An entry added to your CONFIG.SYS file installs the DOS driver.

Microtek ships a different scanner for the Macintosh. You simply plug the supplied cable to the Mac's SCSI port and attach a terminator to the second SCSI port at the rear of the scanner. A driver file resides in the system folder, and the plug-in module goes in the Photoshop folder.

The ScanMaker 600Z is a strong entry in this field, and its $1995 price tag is reasonable. On both PCs and Macs, the scanner is average for speed, but the quality of its images is excellent.



MIRROR 600

A recent entry in the Macintosh color scanner market, the Mirror 600 is a stellar performer that also is nicely priced at $1299. Its vertical 600-dpi resolution accounts for the high quality of its scanned images.

The scanned black-and-white photograph displayed sharp detail and clear contrast. The scanner also produced clear gradations across the gray-scale strip. Color reproduction was faithful. For reproducing RGB values, the Mirror 600 was one of the best, and it placed in the top three for color scanning speed.

The test results for the Mirror 600 were on par with those for the UMAX UC630, which looks almost identical to it. The Mirror 600's scanning bed accepts legal-size documents, and the three-pass scanning method attains 600- by 600-dpi resolution through a software algorithm.

But the scanner makes a rather disconcerting sound upon start-up and whenever it begins a scan job. It growls and clicks as if it's got a screw loose or a part or two missing. The noise is normal, at least for the Mirror 600; it's the sound of the device automatically calibrating its scanning head.

The bundled software set includes a DA and Photoshop 2.0; the Photoshop plug-in works well. Four scanning modes are supported: color, gray-scale, line art, and halftones. Slider bars control resolution and the size of the scanned image. From Photoshop's Image Control window, you can adjust the shadow and highlight values for each RGB channel. For halftone scans, you can apply a dithering pattern to the image. The driver does not permit you to do color scans or zoom in while you are in preview mode.

Installation is a breeze. Mirror comes

release 3.1 shipping

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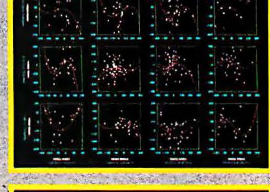
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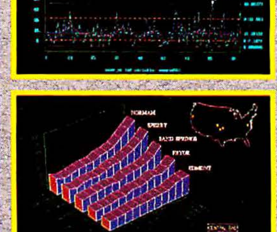
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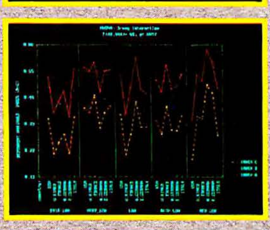


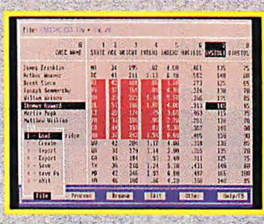


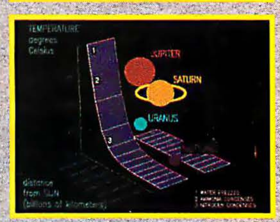




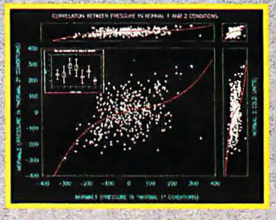


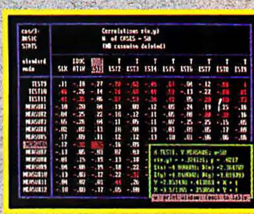


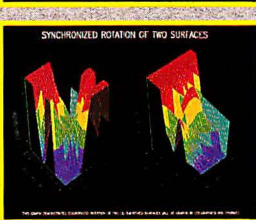


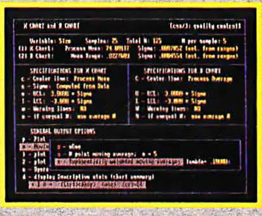


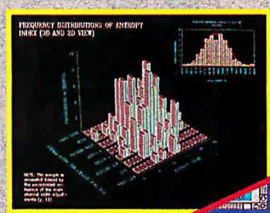


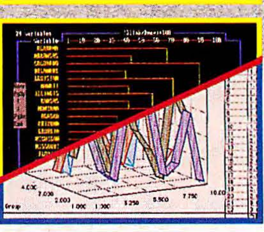


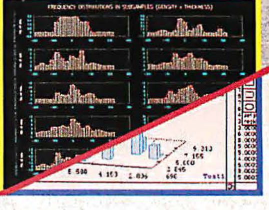


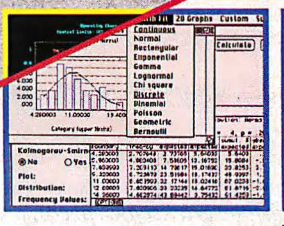


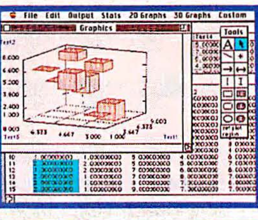






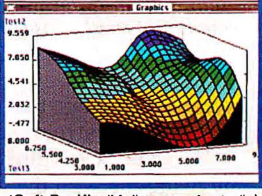






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SPEED BENCHMARKS

Macintosh scanning speeds

◀ Better — Worse ▶

AVR 8000/CLX
Epson ES-300C
HP ScanJet IIc
Microtek ScanMaker 600Z
Mirror 600
Mustek MFS-6000CS
UMAX UC630
XRS Omnimedia 6C

0 50 100 150 200 250
Seconds

PC scanning speeds

◀ Better — Worse ▶

Artix ArtiScan 6000C
AVR 8000/CLX
Epson ES-300C
HP ScanJet IIc
Microtek 600Z
Mustek MFS-6000CS
UMAX UC630
XRS Omnimedia 6C

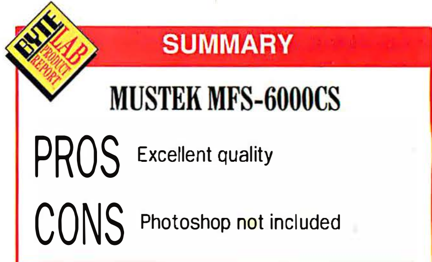
0 200 400 600 800 1000 1200
Seconds

Line-art speed — Gray-scale speed — Color speed

Figure 1: *The graphs show how long it takes each scanner to scan in a color test chart, a black-and-white photograph (gray-scale speed), and a page of text (line-art speed). We tested the scanners on both the Mac and the PC (except for the ArtiScan, because Artix could not send a Mac model in time and the Mirror, which only works on the Mac).*

with a terminator that snaps on between the scanner's rear connector and the SCSI cable. Changing the SCSI address by twiddling with the small rotary switch proved easy because Mirror thoughtfully supplied a jeweler's screwdriver for the job. Dragging a couple of files from the floppy disk to the hard drive completed the software installation.

The Mirror 600 mixes strong performance and high quality with a low price. Photoshop support is solid. We like what we see when we look at the Mirror. It is an excellent scanner that faithfully reproduces color images. But if you want enhancements, such as an add-on device for transparencies or a sheet feeder you'll have to wait. Both still are in the works.



MUSTEK MFS-6000CS

The MFS-6000CS from Mustek (formerly Marstek) is one of the family of similar scanners that includes the Microtek and the X-Ray Scanner Corp. machines. In fact, the Mustek is compatible with the Microtek and uses the same scanner-system driver for PhotoStyler. Even the scanners' cases look similar, and the results from the speed tests are comparable.

The actual hardware resolution of the MFS-6000CS is a nominal 300 dpi, and the maximum resolution attained through the control software is 600 dpi. A standard scanning bed accepts material as large as 8½ inches by 13½ inches. Error detection and self-diagnostic functions are pluses.

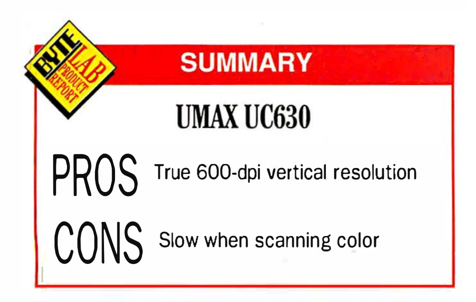
To keep our PC testing consistent, we configured PhotoStyler with the Microtek ScanMaker 600Z driver. The Mustek made a disconcertingly loud rumbling noise during the 300-dpi color scan, and perhaps the attendant vibration was to blame for the poor registration (alignment) of the different colors. Even more troublesome, PhotoStyler crashed several times after we completed the speed tests, so we switched to Picture Publisher for the quality tests.

The speed test results for the color, black-and-white photo, and text scans all fell within 13 seconds of the Microtek ScanMaker 600Z and the XRS Omnimedia 6C. But the real clincher was the excellent quality of the scans for the black-and-white photo, text, and Macbeth color chart. They were among the best in these categories and most closely resembled the original artwork in contrast, detail, and hue.

The Mustek comes bundled with the Picture Publisher 3.0 installation disks, the manual for the limited edition of the software, and Ocron's Perceive Automat-

ic OCR package, which lets the Mustek emulate the Microtek scanner.

Setting up the PC interface kit was as straightforward as with most of the other scanners we tested. As usual, the Mac installation was fast and easy. We capped one rear connector with a terminator, attached the cable to the other connector, and were ready to go. Mustek ships two DA versions, one for doing color scans and the other black-and-white jobs. The Photoshop plug-in has some nice extras, such as gamma correction and a variety of halftone screens. Although the Color It application boasts a large selection of tools, colors, and fill patterns, we still would like to see Mustek bundle a version of Photoshop.



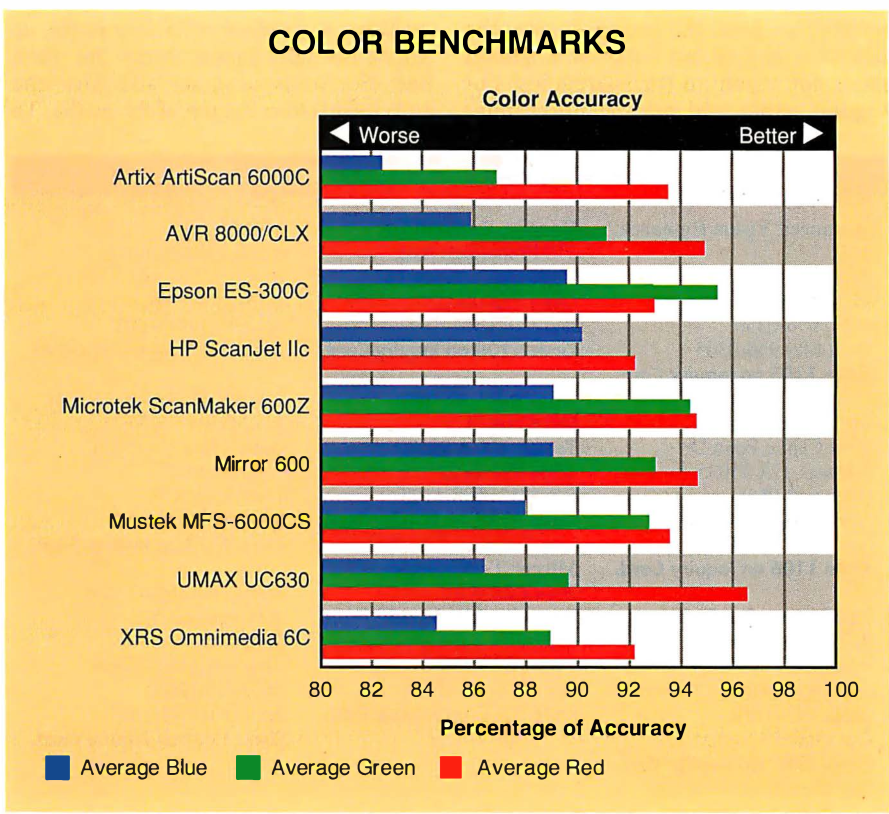


Figure 2: *To test color capability, we scanned in a Macbeth Color Checker Chart. The original CIE color values were converted to RGB by a Tektronix algorithm. We compared the RGB values returned by each scanner to the original baseline values. Each bar (red, green, and blue) represents the accuracy of reproduction of the three primary colors. The higher the three color values, the more accurately the scanner represents colors.*

UMAX UC630

The UMAX UC630 has several notable features to recommend it. First, it delivers true 600-dpi vertical resolution and 600- by 600-dpi interpolated resolution. The scanning bed accepts legal-size paper, and the machine puts in an excellent performance on both the Mac and the PC.

Although it didn't scan the color chart at breakneck speed, the range of colors that it reproduced was very good. Like the Mustek, the UMAX roared when scanning in color, and it did a stellar job of using PhotoStyler and the gray-scale mode to scan our black-and-white photo. The resulting image had excellent contrast and showed detail in the darkest shadows of the original. The unit far outpaced its competitors for its speed at scanning this photo, finishing first—in just 53 seconds. The UMAX UC630 also did well in the gray-scale test, showing differences in all 20 steps from white to black.

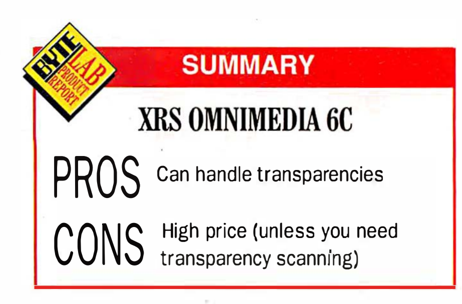
Tests for line quality showed that the UMAX UC630 can handle black-and-white line art equally well. The mixed-text-fonts scan was excellent.

The unit was simple to set up on the Macintosh. We just plugged it in; no terminator was required. Dragging one file into the system folder and another into the Photoshop folder took care of the software end of the setup.

The Photoshop plug-in is well designed. You use slider bars to set resolution and scaling values. The unit's four scan modes accommodate color, gray scales, halftone, and line-art input. The Macintosh software bundle includes a complete version of Photoshop 2.0 and a DA for convenient scanning.

The UMAX UC630's PC interface kit includes the GSII-PC adapter card. A bank of DIP switches sets the adapter address, SCSI ID, and interrupt for the card. A rotary switch sets the SCSI ID for the scanner. Installing the scanner for the PC was a trial-and-error process, demanding a bit of detective work to decode the actual steps. PhotoStyler's driver installation went smoothly, but Picture Publisher's driver crashed our system until we obtained a new version of the driver. The main software package bundled with the PC kit, Image-In Color Professional, contains a complete toolbox that gives you total control of the image editing process and will let you do color separations.

The manual is skimpy, though. We'd like to say it covers the basics, but it doesn't come close. While it discusses the hardware installation on both platforms, it makes no mention of software drivers, jumping directly from hardware hookups to application software. And the section on application programs covers only the Photoshop plug-in. References to PC applications or drivers are nowhere to be found. The UC630 achieved excellent results, but some of the problems we encountered make us hesitate to recommend it.



XRS OMNIMEDIA 6C

The Omnimedia 6C from X-Ray Scanner Corp. boasts a flourish or two that help



set it apart from the crowd. It uses the Microtek engine but supports a special mode for scanning transparencies. For regular paper and prints, the scanner employs a standard reflective mode, in which the bulb moves below the glass bed. For transparencies and film, the bulb travels over the top of the media. To change modes, you simply pop off the scanner cover, slide out a retainer clip, gently pull the bulb from its socket and reinsert it so that the light bar rests above the glass. In a few seconds, you'll be ready to scan your transparencies. No tools are necessary. The Omnimedia 6C also packs a glass sheath to hold the scanned transparency or film in place.

The engine has a horizontal hardware resolution of 300 dpi, but incremental positioning of the light bar doubles the resolution along the vertical plane. The maximum 600- by 600-dpi resolution is achieved through software interpolation.

The scanner steps through a series of self-tests before each scan. Although this hampers its performance a bit, the unit still posted reasonable results on our tests. The plug-in module for Photoshop does not offer a mode for scanning line art, so the gray-scale and line-art results are the same.

We received a pair of scanners from XRS, one for the PC and one for the Macintosh. Other vendors shipped a single scanner with two different interface kits. Installation was simple. On the Mac, we plugged the interface cable into

COMPANY INFORMATION

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fax: (213) 538-1193
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Roseville, MN 55113
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(612) 633-4450
fax: (612) 633-3136
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Mustek, Inc.
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Irvine, CA 92718
(714) 833-7740
fax: (714) 453-1409
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UMAX Technologies, Inc.
3170 Coronado Dr.
Santa Clara, CA 95054
(800) 562-0311
(408) 982-0771
fax: (408) 982-0776
Circle 1112 on Inquiry Card.

X-Ray Scanner Corp.
4030 Spencer St.
Suite 101
Torrance, CA 90503
(310) 214-1900
fax: (310) 214-1474
Circle 1113 on Inquiry Card.

one of the scanner's rear connectors and attached a terminator to the other connector. We then dragged a file into the system folder and another into the Photoshop folder to enable the plug-in module. That was it. The PC version included Microtek's MS-PCY interface card. DIP switches set the SCSI address.

Neither Micrografx nor X-Ray Scanner Corp. supplies a proprietary driver for the XRS Omnimedia 6C. Although Picture Publisher LE communicates through Microtek emulation, the MICROTEK.DSC driver didn't allow data to communicate with the software, producing only error messages. As a result, we had to scan the Macbeth chart in PhotoStyler and then sample the RGB values in Picture Publisher.

The Macintosh software bundle includes a capable DA for simple color scanning chores. It lets you set the SCSI address of the scanner, adjust brightness of the three RGB channels, change resolution and scaling values, and save images to a 24-bit color TIFF file or a color PICT file. The Mac bundle also includes Scanmatch color-calibration software, a complete version of Photoshop 2.0, and a plug-in module for scanning directly from Photoshop.

The Omnimedia 6C got the highest marks for the precision with which it scanned the MicroCopy Resolution Test Chart. In the test-page scan, however, we noticed some loss of detail in the letters set in the smallest type.

The black-and-white photo scan had a bit too much contrast, but otherwise it had good detail. The Kodak Gray Scale Test conducted at 300 dpi did a better job differentiating midrange grays than white or black areas.

Unfortunately, more than just the Omnimedia's black case will catch your eye. The steep $3500 price tag should raise an eyebrow, as well. But if you scan a lot of transparencies, the XRS Omnimedia 6C may be your best bet. Otherwise, the price is simply too high, even though it produces nice-looking scanned images.

Our 24-Bit Picks

We were impressed by the quality of this field. All the scanners produced fine 24-bit color output. Driver support, especially on the PC, is somewhat weak, as is availability of hardware options like sheet feeders, but the market is heading in the right direction. Prices are dropping while features improve.

On both the PC and the Mac, the Epson-300C generated beautiful color scans. We thought it was among the very best in terms of quality output. Unfortunately, good things come to those who wait. The PC model of the Epson was the slowest scanner of the bunch. The Mustek is also noteworthy for its handling of contrast, detail, and hue. For the best balance of performance, quality, price, and features, our nod for a PC scanner goes to the Microtek ScanMaker 600Z. Our choice for a Mac scanner is the Mirror 600. It, too, strikes a nice balance. You may have to wait for hardware additions, but the Mirror's quality and performance are top-notch, and the price can't be beat. The desktop color revolution moves onward. ■

Stanford Diehl is a BYTE technical editor and former testing engineer in the BYTE Lab. David L. Edwards is a consulting editor to the BYTE Lab. They can be reached on BIX as "sdiehl" and "dedwards," respectively.

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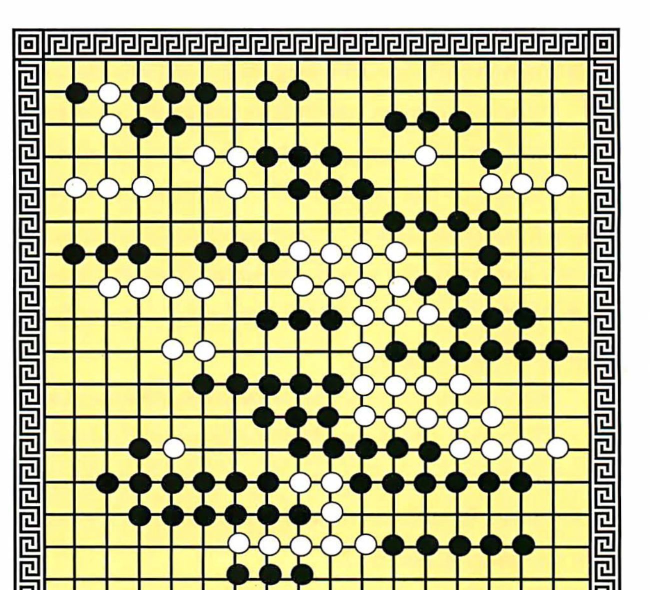
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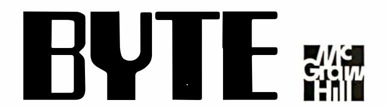
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HARDWARE

Upgrading at the High End

ROGER C. ALFORD

The past few years have seen a proliferation of modular-CPU systems in the PC marketplace. These upgradable systems allow you to enhance system performance by upgrading the microprocessor as your needs change or as faster processors become available. Not only does this approach provide an upgrade path for the consumer, but it also brings relief to the system manufacturer, who no longer has to design a completely new system for each new processor that arrives on the market. And given the incredible pace with which new processors are being introduced by Intel, AMD, and now other manufacturers, this is no small consideration.

The 486 processor market has been especially active. Current family choices include 16-, 20-, and 25-MHz versions of the 486SX; 25-, 33-, and 50-MHz versions of the 486DX; and a 25-MHz version of the 486DX2.

The recent introduction of the Intel 486DX2 processor alters the picture somewhat for upgradable systems, reducing some of their advantage (see "Dueling DX2s: The First 486 Clock-Doublers" on page 259). Intel plans to introduce versions of its clock-doubled chips, which can upgrade existing 25- and 33-MHz DXs on most motherboards, essentially doubling processor performance. This makes the move to higher CPU performance straightforward even for DX owners who don't have a board-upgradable system (although it won't be quite as simple as swapping a replaceable CPU board).

With such a wide selection of devices already available and new variations on the horizon, upgradable-board designs are still very attractive. Even with the introduction of the DX2, modular-CPU systems will still be beneficial for moving beyond the clock-doubled chips to even faster processors, such as a 50- or 66-MHz 486DX or a 586, or for adding larger cache subsystems.

System implementations vary from one manufacturer to another; some systems are based on simple processor replacement boards with little circuitry and no on-board memory, while others have processor boards that are quite complex (see photo 1). These variations result in different base-system prices, upgrade prices, and, of course, system performance levels. (For technical background on upgradable-CPU systems, see "Modular-CPU Designs," November 1991 BYTE.)

I will compare six upgradable systems: Acer's AcerPower 500, Amkly's 486SX/25E, Compaq's Deskpro/M, Dell's PowerLine, IBM's PS/2 Model 90 XP 486, and NEC's PowerMate Express. Each is a board-upgradable 486 design that should carry you well into the future. All these systems are EISA machines except for the Micro Channel–based IBM system.

To compare these machines, I started with a 25-MHz 486SX processor (with two exceptions: a 20-MHz 486SX in the case of the Acer system, and a 25-MHz 486DX for the PS/2 Model 90) and upgraded to a 33-MHz 486DX. The table summarizes each of these configurations.

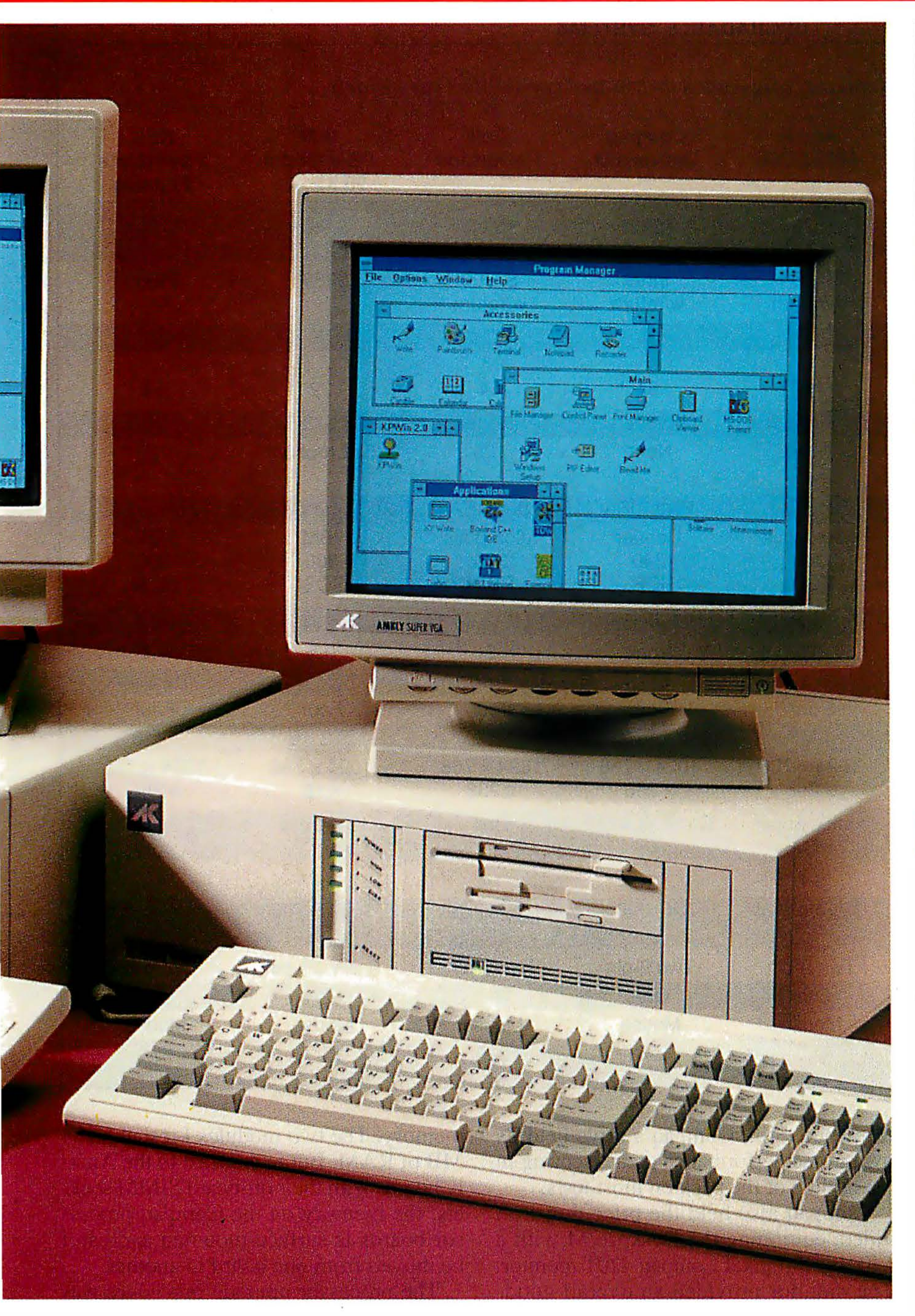
To illustrate the upgrade path of these systems, I've presented the complete system price for a 25-MHz 486SX-based system, along with the cost of upgrading to the faster 33-MHz 486DX processor. In each case, you can also purchase the complete system with the faster processor (as opposed to upgrading) at a cost lower than that of the slower system plus the upgrade.

AcerPower 500

The sturdy chassis of the AcerPower 500 houses a Fujitsu 337-MB SCSI hard drive connected to a Mylex caching SCSI drive controller with 4 MB of cache RAM. An ATI Graphics Ultra video board with 1 MB of video memory and an AcerView 33D monitor provide Super VGA graphics. With the SCSI and video controllers installed, four of the system's six EISA slots remain available; two of the four half-height drive bays also remain unused.

The AcerPower 500's front panel includes power-on, disk-access, and system-speed LEDs, as well as power and reset switches. The keyboard and mouse connectors are conveniently placed at the left side of the front bezel. The AcerView 33D monitor was reasonably bright, but its

Dell's (left) and Amkly's systems are well-constructed and offer a good blend of price and performance.



BYTE ACTION SUMMARY

■ **WHAT UPGRADABLE SYSTEMS ARE**
Upgradable systems are designed around CPU modules and other components that can be easily replaced, providing an inexpensive upgrade path to new technology.

■ **LIKES**
Upgrades are simple; with a wide variety of high-performance processors coming to market, the flexibility of upgradable systems is especially attractive.

■ **DISLIKES**
Upgrades cost considerably more than original purchases; expansion capabilities are often limited.

■ **RECOMMENDATIONS**
Dell's PowerLine system and the Amkly 486SX/25E both provide outstanding performance for a good price, and both are backed by solid support policies.

images were not as crisp as those of some others.

Upgrading the processor board proved to be straightforward. I simply removed the 20-MHz 486SX processor board and plugged in the 33-MHz 486DX board in its place. Next, I ran the EISA Configuration Utilities to ensure that the system was configured properly. There were no hitches and no surprises. The faster board incorporates a 128-KB secondary cache for a performance boost.

With a 20-MHz 486SX processor, the AcerPower 500 costs $7233; the price includes DOS 5.0. An upgrade to the 33-MHz 486DX processor board without the secondary cache costs $1795; the 128-KB cache adds $695 to the upgrade price. Acer provides a $100 credit if you return the original card.

Amkly 486SX/25E

At a list price of $5750 for the 25-MHz 486SX configuration, Amkly's 486SX/25E is the least expensive machine I reviewed. This price, combined with good CPU performance, durable construction, on-site service, and 24-hour, 365-day technical support, makes the Amkly system a good deal. A 33-MHz 486DX upgrade to Amkly's system costs $1200 if you trade in the original processor.

Amkly's entry came with a Micropolis 340-MB ESDI hard drive, a 512-KB Ultrastor caching controller, and two floppy drives. A Super VGA video controller with 1 MB of memory is integrated on the system motherboard. Amkly's own monitor provided a good overall image, although the colors were slightly washed out.

The processor module and other internals are packaged in a stylish, well-built case with a modest footprint. With the hard drive and dual floppy drives installed, the Amkly 486SX/25E has room for only two more 3½-inch internal devices. The drive controller consumed one of the system's six EISA expansion slots, leaving five for additional add-in boards.

Unlike the CPU modules of most upgradables, Amkly's processor boards include memory: four SIMMs in high-density, 32-bit-wide sockets. When you replace a processor board, you must move the SIMMs from the original board to the new one. Fortunately, the 70-nanosecond memory modules that come with the system can be used in any of the existing processor boards, according to Amkly.

continued

UPGRADABLE SYSTEMS

Although each system was delivered in a similar configuration, prices and capabilities vary widely.

	Acer AcerPower 500	Amkly 486SX/25E	Compaq Deskpro/M	Dell PowerLine	IBM PS/2 Model 90 XP 486	NEC PowerMate Express
Price, system (as tested)	$7233	$5750	$6521	$5847	$7495	$7094
Price, upgrade (486DX-33)	$1795	$1200 w/return	$899 w/return	$1700 w/return	$3595	$1889
RAM (as tested; MB)	8	8	8	8	8	8
RAM (maximum on-board; MB)	64	112	64	64	32	64
Cache size (KB)	None	None	None	None	512	None
Cache size (KB; 486DX-33)	128 (option)	None	None	128	512 (option)	128
Expansion slots	Six EISA	Six EISA	Five EISA	Six EISA	Four Micro Channel	Five EISA
Hard drive	Fujitsu	Micropolis	Conner	Micropolis	IBM	NEC
Capacity (MB)	337	340	340	330	300	300
Interface	SCSI	ESDI	IDE	ESDI	SCSI	SCSI
Drive controller	Mylex	Ultrastor	Compaq	Ultrastor	IBM	NEC
Cache RAM (MB)	4	0.5	None	2	0.5	4.5
Floppy drives (MB)	1.44	1.2/1.44	1.2/1.44	1.44	1.2/1.44	1.2/1.44
Drive bays	Four	Four	Four	Four	Four	Four
Video RAM	1 MB	1 MB	1 MB	1 MB	512 KB	1 MB
Video-controller resolution	1024 × 768 × 256	1024 × 768 × 256	1024 × 768 × 256	1024 × 768 × 256	1024 × 768 × 16	1024 × 768 × 256
Monitor type	AcerView 33D	Amkly Super VGA	Compaq 420T	Dell UltraScan	IBM 8515	NEC MultiSync 4FG
Monitor size (inches)	14	14	14	14	14	15
Monitor resolution (pixels)	1024 × 768	1024 × 768	640 × 480	1024 × 768	1024 × 768	1024 × 768
Serial ports	9-pin, 25-pin	Two 9-pin	Two 9-pin	Two 9-pin	9-pin, 25-pin	Two 9-pin
Parallel ports	One	One	One	One	One	One
Other ports	Mouse	Mouse	Mouse	Mouse	Mouse	Mouse
Power supply (W)	200	200	240	224	200	285

Upgrading the system was somewhat involved. With the power off, I removed the 25-MHz 486SX processor board from the system and carefully removed the SIMMs from the board. Then I placed the memory modules into the corresponding SIMM sockets on the 33-MHz 486DX processor board and inserted the new board into the proprietary slot in the system. The system powered up with new pep.

Compaq Deskpro/M

The Compaq Deskpro/M was the only system that came with an IDE hard drive—the others all came with performance-oriented SCSI or ESDI drive subsystems. My test Deskpro/M included two floppy drives and a Conner 340-MB hard drive. The use of an economical IDE drive subsystem instead of a more costly SCSI or ESDI subsystem helped Compaq keep the system price down at the expense of some performance. Still, Compaq's drive held its own in the performance arena, scoring in the middle of the pack on most tests.

Compaq also held the price down on video, equipping the Deskpro/M with a 640- by 480-pixel Compaq 420T monitor. The monitor provided an overall good-quality image with crisp character definitions, but it was not as bright as some others. Compaq's 1-MB Super VGA board will support higher resolutions with other monitors.

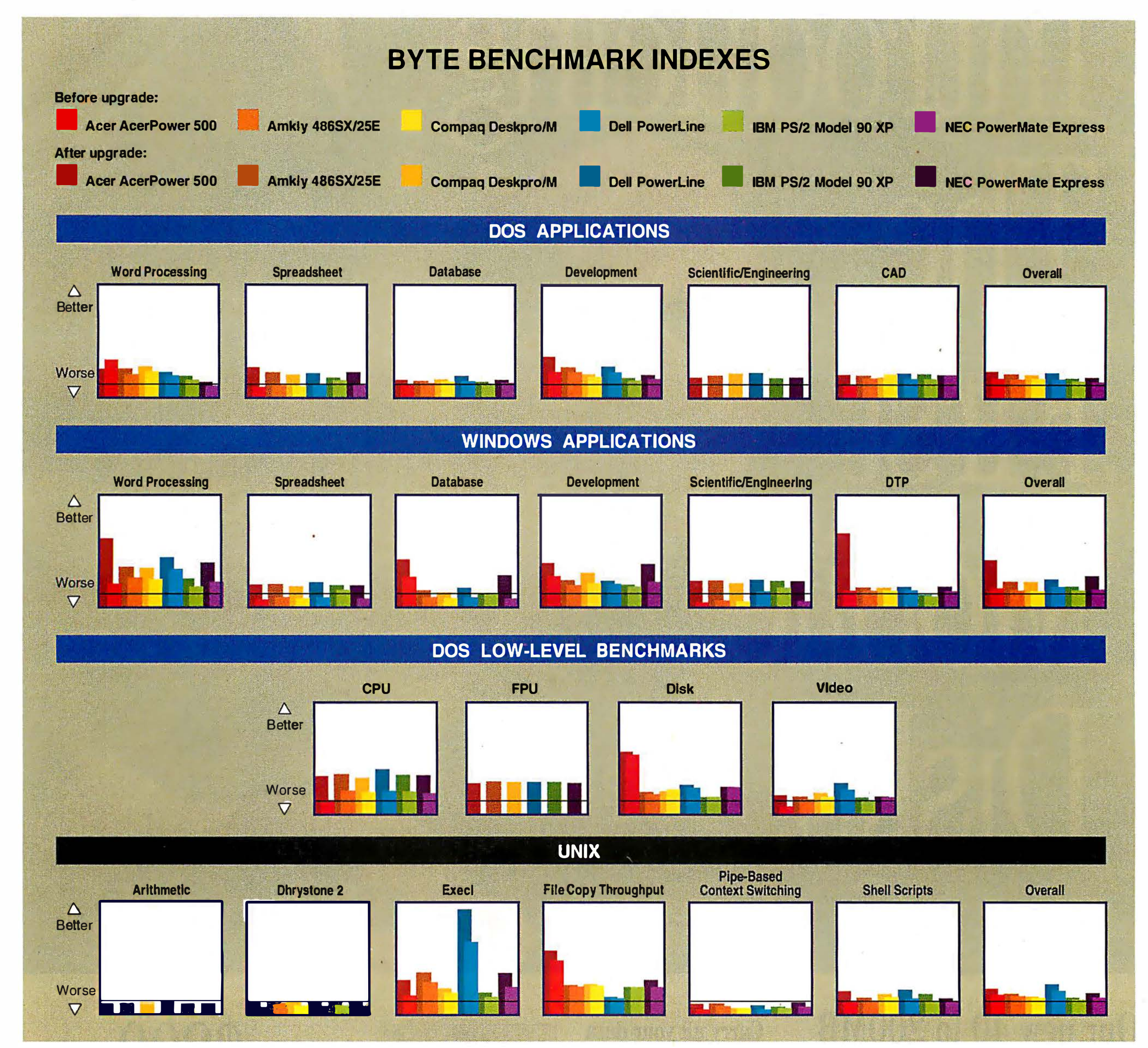
The Deskpro/M comes with a well-constructed case that includes five EISA slots and a proprietary memory slot. The ISA VGA controller board takes up one of the five standard slots. The two floppy drives, the hard drive, and the optional 80-MB backup tape drive together use up the four available system drive bays.

As with Amkly's modules, the Deskpro/M's CPU modules include system memory. The two modules I tested had 4 MB of RAM. But in contrast to the Amkly boards with their on-board SIMM sockets, the memory on the Compaq processor boards is surface-mounted and can't be moved from one board to another.

The processor upgrade procedure was straightforward. I removed the 25-MHz 486SX processor board and installed the replacement 33-MHz 486DX board in its place. The system detected the processor change at the next power-up, prompting me to run the EISA Configuration Utilities to configure the system for the new processor.

The price of the Compaq review system is $6521, not counting the tape drive (which would add $899 to the price); add $99 more for DOS 5.0. The upgrade cost to move from a 25-MHz 486SX to the 33-MHz 486DX processor board is $899 with a trade-in of the original processor board.

continued



All results are indexed, and higher numbers indicate better performance. For each index in the DOS and Windows tests, a Compaq Deskpro 386/33L running Compaq DOS 5.0 and Windows 3.0 = 1. For each index in the Unix tests, a Sun Sparcstation IPC = 1. The overall index is the average index of the individual tests.

The BYTE low-level benchmark suite identifies relative performance at the hardware level, breaking down performance by system component. The results of these tests can help you to identify the relative performance of a given subsystem and to determine where performance bottlenecks may lie. For a complete description of these tests, see "BYTE's New Benchmarks: New Looks, New Numbers," August 1990 BYTE. The BYTE low-level benchmarks, version 2.2, are available in the byte.bmarks conference on BIX, or you can contact BYTE directly.

BYTE's application performance suite measures the performance you can expect to see running a given application category under a given operating environment. We test under two environments: DOS 5.0 and Windows 3.0. We test six application categories for each environment, running test scripts using the following programs: Word Processing: WordPerfect 5.1 and Lotus Ami Pro 2.0; Spreadsheet: Lotus 1-2-3 release 3.1+ and Microsofl Excel 3.0a; Database: Software Publishing Superbase 4 version 1.3 and Borland dBase IV; Development: Borland Turbo Pascal for Windows and Microsoft C 6.0; Scientific/Engineering: MathSoft Mathcad for Windows 3.0, The MathWorks MatLab 3.5k, and Computing Resource Center Biturbo Stata 2.1; CAD: Autodesk AutoCAD release 11; and Desktop Publishing: Aldus PageMaker 4.0. The data files and test scripts are available from BYTE.

Our Unix tests show relative performance for double-precision arithmetic, the Dhrystone 2 benchmark, spawning a process (execl()), file copy throughput, pipe-based context switching, and running a shell script with eight concurrent scripts running. Unix benchmarks are available on Usenet, and in the listings area on BIX.

Benchmark results for six systems, in baseline and upgraded configurations. Acer's baseline model is a 20-MHz 486SX, and IBM's is a 25-MHz 486DX; all others are 25-MHz 486SXes. Upgraded models are 33-MHz 486DXes. Dell's and Amkly's systems turned in excellent processor scores; Acer's and NEC's fast disk subsystems gave those machines excellent numbers overall.

Dell PowerLine

Dell's upgradable PowerLine system proved to be the fastest of the bunch; it also has a reasonable price, is easily upgraded, and has a nice display. The PowerLine came with one 3½-inch 1.44-MB floppy drive and a Micropolis 330-MB ESDI hard drive connected to a 2-MB Ultrastor controller. The system included an embedded Super VGA video controller with 1 MB of memory and was performance-enhanced with a plug-in ATI 8514 Ultra/Vantage video accelerator board. The display quality of Dell's UltraScan monitor was crisp, clear, and bright, and tied

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FEBRUARY 17, 1992

Gateway To Fix Glitch In Its 486 Motherboard

Users Complain of System Lockups

Gateway 2000 is offering to replace the motherboard in certain 486 systems that users said can lock up or report incorrect results when running applications compiled using FORTRAN compilers.

The problem, as reported by several Gateway customers on CompuServe, occurs when the 33MHz 486-based systems run programs that calculate numbers too large or too small for the machine to handle.

. . . on his Gateway 2000 486/33 when the system took the result of its calculations, which was a very small decimal between zero and one, incorrectly changed the result to 10 and kept doing calculations. . .

He said the problem only happens the first time a program is run after the machine is rebooted.

Gateway's Schmith said the firm has only had reports of systems locking up, not generating inaccurate results.

See GATEWAY Page 32

Gateway *Motherboard Fix Offered*

Continued from Page 29

The lockup glitch, he said, is caused by a timing problem that causes the math coprocessor in the 486 CPU to stop functioning before it has finished its calculations.

Micronics Computers Inc., which supplied the motherboards to Gateway, has made a "minor fix" that eliminates the problem, said Edward Ying, Micronics' product marketing manager in Fremont, Calif. Micronics has supplied Gateway with the new motherboards, he added.

Schmith said the problem only occurs on Industry Standard Architecture (ISA) versions of the 33MHz 486 Gemini motherboard. He added, however, that Gateway is not sure how many systems were released with the faulty motherboards.

Gateway, which has received approximately 50 complaints about the problem, will replace the motherboards free of charge, he said. The company can be reached at (800) 523-2000. ■

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- Computers Buyers Guide awarded TOUCHE's 486-33 it's BEST BUY award, stating it was "one of the fastest computers ever tested" after comparing TOUCHE, Northgate, Gateway 2000 and 6 others!
- In May 1992 Computer Shopper compared 8 486 EISA systems including ZEOS and Gateway 2000. TOUCHE "had the best price/performance ratio!"

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with NEC's monitor for the title of best display.

In addition to the standard LEDs and switches, Dell's front panel includes a SmartVu display. This four-character alphanumeric display provides information about what's being tested during POST (power-on self test) and provides diagnostic information if a problem occurs. Dell provides the necessary technical information to allow you to write applications that control the display.

Upgrading the PowerLine is simply a matter of swapping cards. The Dell CPU boards have a short braided ground cable that must be screwed to the chassis. The system powered up and worked fine after I replaced the processor board, and it gave no warning message about system reconfiguration; however, the manuals instruct you to run the EISA Configuration Utilities after you install a new board.

Dell's durable system case was a little larger than all but the NEC system, and it housed six EISA slots. Two of the EISA slots were consumed by the ATI and Ultrastor boards, and a third was taken up by an Adaptec SCSI controller that attached to an optional 525-MB QIC (quarter-inch-cartridge) tape drive. With the tape drive installed, the system's bays were all occupied.

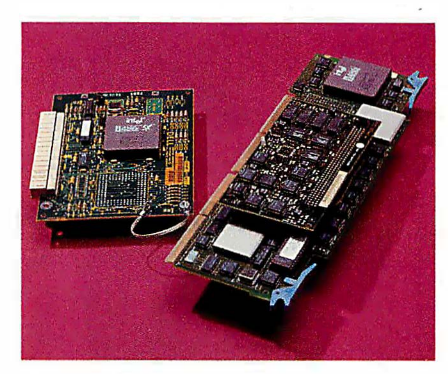


Photo 1: *Systems vary in the division of labor between upgrade card and system board: Dell's simple 33-MHz 486DX upgrade card (left) includes little more than the processor, while IBM's module includes cache RAM and support logic.*

A Dell PowerLine 425DE built around a cacheless 25-MHz 486SX processor board sells for $5847. My test system also included a bundle with DOS 5.0, Windows 3.1, and a mouse ($149), and the tape drive subsystem ($1248). The cost of the 33-MHz 486DX processor upgrade board, which includes 128 KB of secondary cache, is $1700 with a trade-in of the original CPU module.

IBM PS/2 Model 90 XP 486

The Model 90 has an appealing small footprint, and, with two thumbscrews in the back, it's easy to get into. The enclosure houses a 200-watt power supply, four drive bays, and four Micro Channel expansion slots. Proprietary slots near the replaceable processor board contain the system memory.

IBM provides for a simple processor upgrade procedure: You just open the case and swap processor cards. At power-up, the system will automatically detect the new processor and ask if you want to autoreconfigure; selecting yes will automatically reconfigure the system for the new CPU.

IBM's baseline board was built around a 25-MHz 486DX. Oddly, the 25-MHz 486DX processor board comes standard with 512 KB of secondary cache, while the 33-MHz 486DX processor board comes with no cache but accepts a 512-

..rcard (my review system in- ..e cache on both boards). The ..l 90 XP 486 with the 25-MHz ..DX processor costs $7495; add $165 ..or DOS 5.0. The cost to upgrade to a 33-MHz 486DX board is a whopping $3595, plus an additional $1995 for the cache module.

My review unit came with two floppy drives and an IBM 300-MB hard drive connected to an IBM SCSI controller with 512 KB of cache memory. The system board includes integrated XGA video with 512 KB of RAM (expandable to 1 MB). The Model 90 came with an IBM 8515 monitor; the 8515 provided only mediocre image quality, and it lacked the crispness and brightness found in competing monitors.

NEC PowerMate Express

The PowerMate Express system was the "beast" among these machines, boasting the largest footprint of the group and weighing much more than its nearest competitor. The weight of the system is due in part to its enormous hard drive. While all the other review systems included either 3½-inch hard drives or light 5¼-inch half-height drives, the NEC system came with a big, heavy, 5¼-inch full-height drive—unusual considering current drive technology.

The big 300-MB NEC SCSI drive was connected to an NEC SCSI controller with 4.5 MB of cache memory. The system includes one full-height and three half-height drive bays. With the hard drive and two floppy drives, only one half-height bay remained open. The case also holds a hefty 285-W power supply and five EISA expansion slots; one of these slots was occupied by the SCSI controller, leaving four free slots.

My review system included an integrated Super VGA video controller with 1 MB of memory and a 15-inch NEC MultiSync 4FG monitor. Considering NEC's leadership in the monitor business, it's no surprise that the 4FG had one of the best-looking displays among these systems.

Upgrading the processor board proved more difficult with the PowerMate Express than with the other review systems. When I installed the new processor board and ran the EISA Configuration Utilities, the system reset all the setup parameters (including non-processor-related items such as boot-drive selection) to a default state. This quirk was not well documented in the system manual, and I had to manually reconfigure several parameters to get the system back to normal.

The 25-MHz 486SX processor board includes no secondary cache, but the 33-MHz 486DX includes a 128-KB cache. The price for a complete NEC PowerMate Express system is $7094; this includes DOS 5.0, Windows 3.1, and a mouse. The cost of the 33-MHz 486DX processor upgrade board is $1889. Return credit depends on the reseller, but NEC says a typical offering is about $400 for the original processor board.

Flexible, but Fast?

The figure shows benchmark results for these six systems—both pre-upgrade and post-upgrade results. All the systems scored in the range you'd expect given their processors; an upgradable design need not skimp on performance.

The overall performance leader is the Dell PowerLine, with the fastest CPU index value in both baseline and upgraded configurations. Amkly's system finished a close second in both categories. Compaq's Deskpro/M also turned in good scores in the baseline configuration, but the Deskpro lagged when all the systems were upgraded.

Dell's PowerLine also excels in the video-performance category. The Deskpro/M took a distant second place, followed closely by the rest of the pack. The IBM and Amkly systems had disappointing showings in this area.

Acer's 20-MHz processor speed naturally kept it from being a serious performance contender in the baseline processor category, but the company makes a point with its SCSI disk subsystem. The performance of the 4-MB-cached drive left the other systems in the dust on BYTE's disk tests. Disk performance also explains the Acer's outstanding results in some application categories, such as word processing and desktop publishing.

Dell and NEC shared second place in the disk performance arena, and Compaq held the middle ground with its low-cost IDE disk subsystem. With their speedy disk subsystems, the AcerPower 500 and the NEC PowerMate Express both posted outstanding scores on BYTE's application suite.

While all these systems offer features and trade-offs worth considering, the Dell PowerLine and the Amkly 486SX/25E stand out as good choices. The well-constructed PowerLine provides the best overall performance at a competitive price, and it's backed by a solid reputation and support policy. The Amkly 486/25E is another solidly built system with very good processor performance and a low price tag. Amkly's on-site service and around-the-clock technical support further enhance its value. ■

Roger C. Alford is a BYTE consulting editor and president of Programmable Designs, a Michigan-based electronics design firm. You can contact him on BIX as "rogera."

COMPANY INFORMATION

Acer America Corp.
(AcerPower 500)
2641 Orchard Pkwy.
San Jose, CA 95134
(800) 733-2337
(408) 432-6200
fax: (408) 432-6221
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Amkly Systems
(486SX/25E)
60 Technology Dr.
Irvine, CA 92718
(714) 727-0788
fax: (714) 727-9521
Circle 1233 on Inquiry Card.

Compaq Computer Corp.
(Deskpro/M)
P.O. Box 692000
Houston, TX 77269
(800) 345-1518
(713) 378-8820
Circle 1234 on Inquiry Card.

Dell Computer Corp.
(PowerLine)
9505 Arboretum Blvd.
Austin, TX 78759
(800) 289-3355
(512) 338-4400
fax: (512) 343-3653
Circle 1235 on Inquiry Card.

IBM Corp.
(PS/2 Model 90 XP 486)
1133 Westchester Ave.
White Plains, NY 10604
(800) 426-9292
Circle 1236 on Inquiry Card.

NEC Technologies, Inc.
(PowerMate Express)
1414 Massachusetts Ave.
Boxborough, MA 01719
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(508) 264-8000
fax: (508) 264-8673
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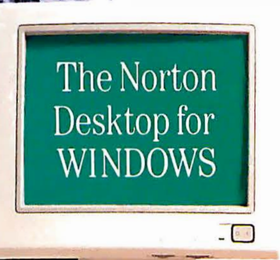
How is this possible? The Norton Desktops provide a unified visual approach—a desktop—that speeds and simplifies the way you work in DOS or Windows by granting easier access to the files, documents, and applications you use every day. While supplying a full array of non-technical tools that enhance the way you work and protect the results.

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The Norton Desktop for DOS



The Norton

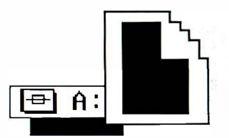
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Norton Desktop For DOS

File Disk View Configure Tools Window Help

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And you can do all this with the security of Norton's acclaimed backup, virus protection, and data recovery utilities. You can even set up schedules to automate your backup and virus scans, so you'll never have to worry about losing data.

All, without using a single DOS command!

Plus, when you're in between work sessions, colorful, animated screen savers pop up over any application.

Double-click on a drive icon to see all your files in a movable, re-sizable window. Below it is a view pane showing a spreadsheet or any type of file you wish to preview.

Simply click on a file and drag it to our unique button bar to backup, print, or take other actions.

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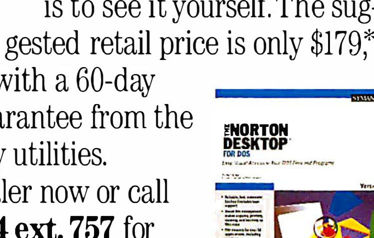
Because its companion, The Norton Desktop for Windows, uses the same interface and commands, you'll have an easy migration path to Windows.

The Norton Menu lists the programs on your hard drive—just click on a name to launch.

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The only way to truly appreciate The Norton Desktop for DOS is to see it yourself. The suggested retail price is only $179,* and it's backed with a 60-day money-back guarantee from the leader in quality utilities.

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1Help 2Menu 3NAV 4Backup 5Find 6Print 7Move 8Copy 9Delete 10PullDn

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A:

C:

Network

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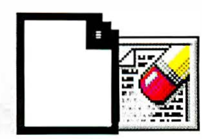
And the customizable button bar puts often-used functions at your fingertips.



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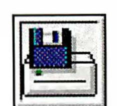


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The Norton Desktop for Windows comes with a full set of utilities, including fast automatic backup; precision data recovery (with SmartErase™); comprehensive virus protection; and more.

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"I never run Windows without it." Walter S. Mossberg
Wall Street Journal, 4/2/92







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The Norton Desktop for DOS.

Makes DOS Easier

1. Simple, intuitive drag-and-drop interface
2. Over 60 file viewers, so you can view file contents without launching the application
3. Powerful file management; allows you to find, view, backup, virus scan, copy, and more
4. Automatic Scheduler launches programs at any time
5. Pop-up reminders for meetings, phone calls, appointments, etc.
6. Full keyboard support for users without a mouse

Organizes Your Applications

7. Norton Menu loads applications with a keystroke
8. Autobuild™ feature automatically creates a menu of applications

Dependable Virus Protection

9. Protects against over 1,000 viruses—with FREE updates for protection against new viruses
10. Automatically protects in the background—using only 1K of memory (loads high)

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13. Advanced data verification to ensure reliability
14. Restores data even from damaged backup disks

Automatic Data Protection and Recovery

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16. SmartCan™ provides 100% recovery of deleted files even on a network

Portable Computing

17. Fast serial and parallel file transfer between your portable and desktop PC
18. Compares laptop and PC directories to keep contents current

Network Ready

19. Easily transfers files between computers on a network
20. Network installation available, with full support for Novell, LAN Manager, Banyan, LANTASTIC, and all NetBIOS-compatible networks

And More

21. Colorful screen savers with password protection
22. Disk cache boosts performance
23. Speed Disk™ optimizes hard drive performance
24. Transparent drag-and-drop file compression/decompression in ZIP format
25. Optional Norton Commander® mode

System Requirements

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—IBM PC, XT, AT, PS/2, or 100% compatibles
—512K RAM
—Hard drive required

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Makes Windows Easier To Learn and Use

NEW 1. Global drag-and-drop across the entire desktop
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NEW 4. Graphical, expandable tree directory views by date, file type, size, or alphabetic order
NEW 5. Over 45 file viewers (including 19 new ones) let you view files without launching applications; permits searches from viewer
6. Animated color screen savers with optional password protection
NEW 7. View groups as icon toolbox or menu
NEW 8. Desktop arrange keeps your desktop organized
NEW 9. Customizable fonts
NEW 10. Enhanced Windows text editor (Desktop editor)

Fast, Automatic Backup

11. Schedule background or unattended backups
12. Fast—up to 5.6 MB per minute
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18. Automatically protects in the background—using only 1K of memory (loads high)

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19. Launch Manager starts a new program from one that's running. Access applications directly from Windows Control Menu
20. SuperFind searches drives and network servers for files by name, extension, attributes, date, and text strings
NEW 21. Batch Builder™ and Macro Builder™ help you build your own menus and automate tasks
22. Icon Editor and Librarian lets you use and customize a library of over 150 icons
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Network Features

NEW 24. Network installation available, with full support for Novell, LAN Manager, Banyan, LANTASTIC, and all NetBIOS-compatible networks
25. Includes network security features like restricted file launching from drive windows

System Requirements

—DOS 3.1 or higher
—Windows 3.0 or higher
—IBM AT, PS/2 or 100% compatibles
—2 MB or more RAM (3 MB recommended)
—9 MB free disk space (for full installation)
—EGA, VGA, XGA, or SVGA video card

To see how The Norton Desktop for DOS or Windows can truly change the way you work with PCs forever, see your nearest retailer today.



HARDWARE

Dueling DX2s: The First 486 Clock-Doublers

ROGER C. ALFORD

Intel's new 486DX2 creates a balance that's hard to beat. Naturally, the major goal in processor advancement is increased performance. But as processors get faster, the rest of the system must also improve, increasing speed requirements (and hence the cost) of main memory, cache, and control logic, and making board layout considerably more difficult.

Enter the 486DX2-50. This is a 50-MHz processor that isn't. Externally, the DX2 runs on a 25-MHz clock; internally, the processor runs at 50 MHz. A special on-chip circuit doubles the clock on the processing unit, FPU, and 8-KB on-chip cache. (You can find details on the DX2's operation in "Intel's Double-Fast CPUs," May BYTE.)

The slow bus interface can act as a bottleneck in some applications; the DX2-50 is not quite as quick as a full 50-MHz 486DX. However, you will likely see a noticeable performance improvement with the DX2 processor over a 33-MHz 486DX. Since typical applications execute 80 percent to 90 percent of their instructions from the 486's on-chip cache, the slower external data-gathering abilities of the 486DX2 put only a small drag on performance.

Because the 486DX2-50 is a *near* drop-in replacement in existing 25-MHz 486 designs, and because of the proliferation of upgradable-CPU systems, it took almost no time for system manufacturers to introduce the first DX2 machines. Indeed, a few of the first ones lacked system documentation that even mentioned the new DX2 chip. I've reviewed eight of the first DX2s to hit the market: clock-doublers from Compaq, Dell, Gateway 2000, International Data Systems, NCR, Northgate, Tandy, and Zeos.

Although they sell for only a modest premium over their 486DX/33-based siblings, these DX2s encroach on performance levels previously reserved for the 50-MHz 486DX. I give my impression of each system below; you'll find the details of each configuration in the table.

A note of caution: The existing DX2 chip is not quite pin-compatible with the 486DX, so don't try to get one to replace the chip in your DX system. Intel is expected to release a version of the DX2 to the consumer market this year that will replace existing DX chips.



Photo 1: *Compaq's Deskpro 50M and the IDS450i2 are both excellent choices among 486DX2 systems; the Deskpro 50M is well built and features an excellent graphics system, while the IDS450i2 is fast and inexpensive.*

Compaq Deskpro 50M

The Compaq Deskpro 50M is an upgradable EISA system that allows even faster processors to be installed as they become available and as you have need. It shares all but its video and processing subsystems with the Deskpro/M I reviewed in "Upgrading at the High End," page 246.

The Deskpro 50M includes Compaq's latest QVision video interface with 1 MB of VRAM (video RAM). An EISA version of the QVision VGA+ controller came with the system, offering fast video performance. The 15-inch QVision 150 flat-screen monitor provides a nice video output—the best of the systems I tested.

The Deskpro 50M (see photo 1) has an attractive, solidly built system case with a 240-watt power supply and a built-in PS/2-type mouse port, but it lacks a reset switch. The replaceable processor board itself includes 8 MB of surface-mounted RAM, but additional memory can be added to the system via a proprietary memory-expansion board that accepts high-density, 32-bit-wide SIMMs. The price of the review system as tested is $7373.

Dell PowerLine 450DE/2

Another upgradable EISA machine, the Dell PowerLine 450DE/2 includes two floppy drives, a 320-MB Maxtor IDE hard drive, and an integrated 1-MB Super VGA video interface with fast performance. The system includes a Dell UltraScan monitor, which provides a bright, crisp image. Except for the processor module, an ATI Ultra video controller, and the hard drive subsystem, this system is identical to the PowerLine 425DE I reviewed in my roundup of upgradable systems. The PowerLine 450DE/2 sells for $5477.

Gateway 2000 50-MHz 486DX2 EISA

My Gateway review system was a desktop model, but all Gateway 2000 EISA systems now come standard in a tower case (the desktop case is optional). While attractively styled, the all-white desktop case lacks the strength and ease of entry offered by most of the other systems; nonetheless, it is adequate. A 124-key "AnyKey" keyboard comes with the system, too, with function keys both across the top and at the left side. For even greater flexibility, any function can be assigned to any key, and even a series of keystrokes can be assigned to a single key.

The system also includes a Diamond SpeedStar Plus Super VGA video-controller board with 1 MB of RAM and a

486DX2 SYSTEMS

Features of 486DX2 systems. As with any system, the processor alone does not determine overall performance; the hard drive, the drive controller, and the capability of the graphics system will make significant contributions.

	Compaq Deskpro 50M	Dell PowerLine 450DE/2	Gateway 2000 50-MHz 486DX2 EISA	IDS IDS450i2	NCR System 3335	Northgate Elegance ZXP	Tandy 4850 EP	Zeos 486DX2-50
Price (as tested)	$7373	$5477	$3895	$3700	$8090	$4599	$5447	$4305
RAM (as tested; MB)	8	8	8	8	8	8	8	8
RAM (maximum on-board; MB)	64	64	64	96	64	32	32	32
Cache size (KB)	256	0	64	64	0	64	0	128 option
Expansion slots	Five EISA	Six EISA	Eight EISA	One 8-bit, seven 16-bit	Four Micro Channel	One 8-bit, six 16-bit	Three 16-bit	One 8-bit, seven 16-bit
Hard drive	Conner	Maxtor	Maxtor	Micropolis	Maxtor	Micropolis	Seagate	Seagate
Capacity (MB)	340	320	340	320	340	300	202	426
Interface	IDE	IDE	SCSI	SCSI	SCSI	SCSI	SCSI	SCSI
Drive controller	Compaq	Integrated	Adaptec	Adaptec	NCR	Adaptec	Adaptec	Adaptec
Floppy drives (MB)	1.2/1.44	1.2/1.44	1.2/1.44	1.2	1.44	1.2/1.44	1.44	1.2/1.44
Drive bays	Four	Four	Five	Five	Three	Five	Three	Eight
Video RAM	1 MB	1 MB	1 MB	1 MB	1 MB	1 MB	512 KB	1 MB
Video-controller resolution	1024 × 768 × 256	1024 × 768 × 256	1024 × 768 × 256	1024 × 768 × 256	1024 × 768 × 256	1024 × 768 × 256	1024 × 768 × 16	1024 × 768 × 256
Monitor type	Compaq QVision 150	Dell UltraScan	CrystalScan 1024NI	Helm Impression Plus	NCR Super VGA	Panasonic PanaSync C1381i	Tandy VGM 440	Zeos Super VGA
Monitor size (inches)	15	14	14	14	14	14	14	14
Monitor resolution (pixels)	1024 × 768	1024 × 768	1024 × 768	1024 × 768	1024 × 768	1024 × 768	1024 × 768	1024 × 768
Serial ports	Two 9-pin	Two 9-pin	9-pin, 25-pin	Two 9-pin	25-pin	Two 9-pin	Two 9-pin	9-pin, 25-pin
Parallel ports	One	One	One	One	One	One	One	One
Other ports	Mouse	Mouse	Game	None	Mouse	None	Mouse	Game
Power supply (W)	240	224	200	220	215	220	100	300

BYTE ACTION SUMMARY

- **WHAT 486DX2 SYSTEMS ARE**
  Intel's new 486DX2 processor runs at 50 MHz internally, but it runs on a 25-MHz clock; these systems take advantage of the DX2 to provide good performance for relatively little cost.
- **LIKES**
  DX2 systems run nearly as fast as full 50-MHz systems but cost only a little more than 33-MHz 486 machines.
- **DISLIKES**
  Systems without an external cache show poorer CPU performance.
- **RECOMMENDATIONS**
  Compaq's Deskpro 50M and the IDS450i2 both provide excellent performance; the Deskpro offers outstanding graphics, while the IDS450i2 beats the other systems on price.

Gateway CrystalScan 1024NI monitor. The monitor provides a bright display, although not quite as crisp as some of the others. The Gateway 2000 system enhances the DX2 processor with 64 KB of fast cache memory. The price of the system is a very competitive $3895.

International Data Systems IDS450i2

The IDS450i2 has a cloney look, with a large, conventional, flimsy beige case and third-party everything assembled into a system (see photo 1). But looks can be deceiving—this machine has guts.

The system's AMI motherboard supplements the DX2 with a 64-KB cache and cranks out the fastest CPU performance of the systems that I tested. The IDS450i2 also includes a 220-W power supply and eight ISA expansion slots, six of which remain available for additional add-in boards.

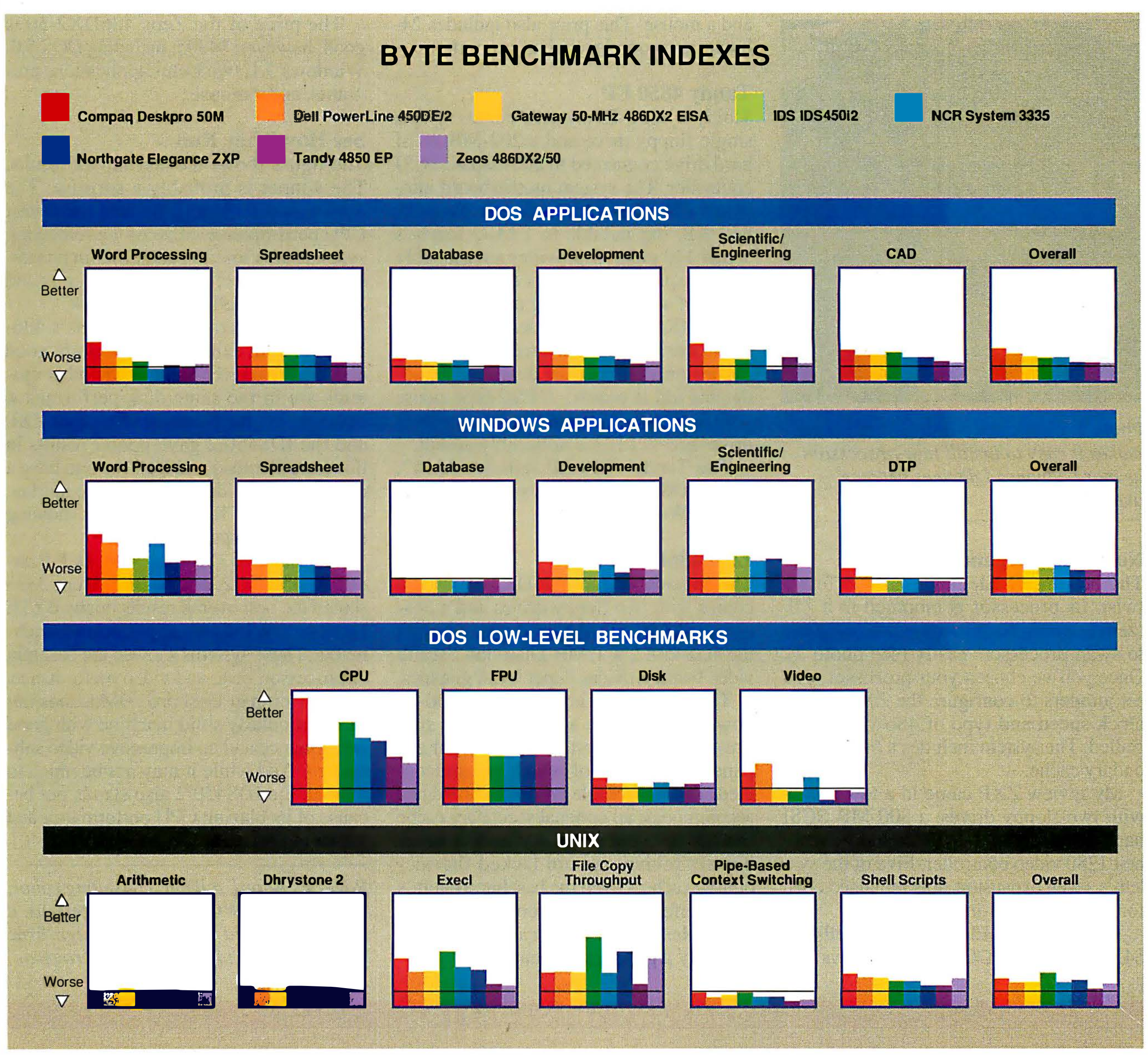
The price of the IDS450i2 is an appealing $3700, which includes DOS 5.0, Windows 3.1, and a mouse. IDS provides telephone technical support. For the price, you get a DX2 system with a 320-MB SCSI hard drive, a Diamond Stealth video board with 1 MB of RAM, and a bright, clear Impression Plus display monitor from Helm Engineering.

NCR System 3335

The NCR System 3335 is an upgradable Micro Channel system, following in the tradition of IBM's PS/2 line. The machine comes with a single floppy drive and a Maxtor 340-MB SCSI hard drive that's attached to a fast NCR SCSI controller. A Super VGA video controller with 1 MB of VRAM is integrated onto the motherboard. NCR's Super VGA monitor provides a bright, crisp image.

NCR provides a memory subsystem alternative that is not currently offered by any other PC manufacturer I know: EDAC (error detection and correction) memory. While conventional parity memory (found in almost all PCs) can detect single-bit errors, it cannot correct errors or even detect errors that affect more than 1 bit. The more advanced EDAC memory can detect and correct single-bit memory errors and detect errors of 2 bits. You can choose between standard parity memory and EDAC memory when you purchase the system.

The price of the NCR system with 16 MB of EDAC memory is $9130. If you



All results are indexed, and higher numbers indicate better performance. For each index in the DOS and Windows tests, a Compaq Deskpro 386/33L running Compaq DOS 5.0 and Windows 3.0 = 1. For each index in the Unix tests, a Sun Sparcstation IPC = 1. The overall index is the average index of the individual tests.

The BYTE low-level benchmark suite identifies relative performance at the hardware level, breaking down performance by system component. The results of these tests can help you to identify the relative performance of a given subsystem and to determine where performance bottlenecks may lie. For a complete description of these tests, see "BYTE's New Benchmarks: New Looks, New Numbers," August 1990 BYTE. The BYTE low-level benchmarks, version 2.2, are available in the byte.bmarks conference on BIX, or you can contact BYTE directly.

BYTE's application performance suite measures the performance you can expect to see running a given application category under a given operating environment. We test under two environments: DOS 5.0 and Windows 3.0. We test six application categories for each environment, running test scripts using the following programs: Word Processing: WordPerfect 5.1 and Lotus Ami Pro 2.0; Spreadsheet: Lotus 1-2-3 release 3.1+ and Microsoft Excel 3.0a; Database: Software Publishing Superbase 4 version 1.3 and Borland dBase IV; Development: Borland Turbo Pascal for Windows and Microsoft C 6.0; Scientific/Engineering: MathSoft MathCAD for Windows 3.0, The MathWorks MatLab 3.5k, and Computing Resource Center Biturbo Stata 2.1; CAD: Autodesk AutoCAD release 11; and Desktop Publishing: Aldus PageMaker 4.0. The data files and test scripts are available from BYTE.

Our Unix tests show relative performance for double-precision arithmetic, the Dhrystone 2 benchmark, spawning a process (execl()), file copy throughput, pipe-based context switching, and running a shell script with eight concurrent scripts running. Unix benchmarks are available on Usenet, from Demolink, in the listings area on BIX, or on disk.

IDS's IDS450i2 turned in a surprising first-place finish on BYTE's low-level CPU benchmarks. The AMI-based 486DX2, equipped with a 64-KB cache, outran the others despite its least-expensive status. When it came to application tests, however, the Compaq, Dell, and NCR machines shared top honors.

opt for 8 MB of parity memory, which is closer to the configuration offered by other vendors, the System 3335 will run you $8090.

NCR's system has an attractive, solid build, with a modest footprint. Under the hood are four unused Micro Channel expansion slots (three 32-bit, one 16-bit) and six proprietary slots. The proprietary slots accept the replaceable CPU board, the SCSI controller, and up to four memory-expansion boards; the fourth memory-expansion slot overlaps the 16-bit Micro Channel slot, so both can't be installed simultaneously. All three of the system's drive bays are for 3½-inch drives; the case makes no mechanical provision for 5¼-inch drives.

continued

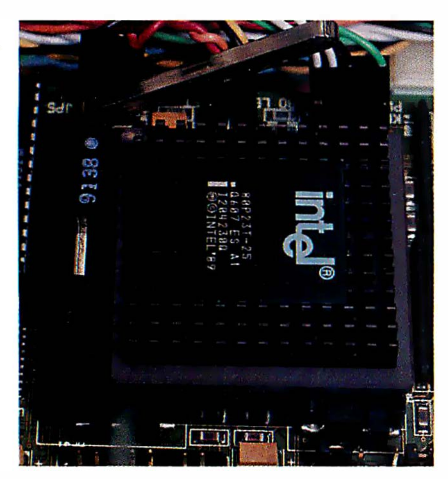


Photo 2: *Northgate's unique ZIF socket makes it easy to install new processors as more advanced devices become available.*

Northgate Elegance ZXP

The Northgate Elegance ZXP offers a twist. Its processor is mounted in a ZIF (zero insertion force) socket, allowing you to swap processors easily (see photo 2). Once you've chosen your processor, you set jumpers to configure the ZXP for the clock speed and type of 486 you've installed. The system includes a 64-KB secondary cache.

My review ZXP came in a tower case with two floppy drives, a 300-MB SCSI hard drive, and a 1-MB Orchid Fahrenheit 1280 video controller. Five of the system's seven expansion slots remained open for additional add-in boards.

The Northgate Elegance ZXP sells for $4599, including DOS 5.0, Windows 3.1, and a mouse. This price also includes 24-hour, year-round technical support.

Tandy 4850 EP

Tandy's 4850 EP system comes with a single floppy drive and a 202-MB SCSI hard drive connected to an Adaptec SCSI controller. The system motherboard integrates a Super VGA video controller with 512 KB, expandable to 1 MB. Tandy's VGM 440 monitor provides a reasonably good display, but it lacks the color brilliance of some competing monitors.

This ISA system includes a lowly 100-W power supply and three 16-bit ISA expansion slots (two are available for additional add-in boards). A PS/2-type mouse port is included, but a front-panel hard drive–access LED is noticeably absent.

The Tandy 4850 EP sells for $5447, with DOS 5.0, Windows 3.1, and Microsoft Works.

Zeos 486DX2-50

The upgradable Zeos 486DX2-50 system comes with two floppy drives and a Seagate 426-MB SCSI hard drive. As with the IDS450i2, a 1-MB Diamond Stealth video board provides Super VGA graphics.

The tower case holds a hefty 300-W power supply with a built-in surge suppressor, and the system offers eight expansion slots, six of which are unoccupied. The replaceable processor board can accommodate an optional secondary cache module to boost processor performance, but my review system lacked the secondary cache. Given the baseline system's weak performance when compared to other DX2s, the $200 128-KB cache module is probably a good investment.

The price of the Zeos 486DX2-50 is good, however: $4305, including DOS 5.0, Windows 3.1, two Lotus applications programs, and a mouse.

See How They Run

The figure shows the benchmark results. The winner is probably a surprise: The AMI-based IDS450i2 showed the fastest CPU performance. Most of the remaining systems are close to each other in processor performance, although the Tandy and Zeos systems fell behind the pack.

NCR's System 3335 and Zeos's 486-DX2-50 both exhibited particularly good disk performance. Most of the other systems are in the same disk-performance ballpark, but the Northgate Elegance ZXP and the IDS450i2 gave poorer results in this area. Compaq and Dell seem to have a corner on the video-performance market, although the NCR System 3335's showing is also quite respectable.

The Compaq Deskpro 50M, Dell PowerLine 450DE/2, and NCR System 3335 scored the best overall results on the BYTE DOS and Windows application benchmarks. These systems showed the best mix of processor, disk, and video performance.

The Compaq Deskpro 50M stands out as a particularly solid machine with good performance and an impressive video subsystem. And while it may not be much to look at, the IDS450i2 also stands out because of its blazing CPU performance and appealing price. ■

Roger C. Alford, a BYTE consulting editor, is president of Programmable Designs, a Michigan-based electronics design firm. You can contact him on BIX as "rogera."

COMPANY INFORMATION

Compaq Computer Corp.
(Compaq Deskpro 50M)
P.O. Box 692000
Houston, TX 77269
(800) 345-1518
(713) 378-8820
Circle 1224 on Inquiry Card.

Dell Computer Corp.
(Dell PowerLine 450DE/2)
9505 Arboretum Blvd.
Austin, TX 78759
(800) 289-3355
(512) 343-3653
fax: (512) 338-8700
Circle 1225 on Inquiry Card.

Gateway 2000
(Gateway 50-MHz 486DX2 EISA)
610 Gateway Dr.
North Sioux City, SD 57049
(800) 523-2000
(605) 232-2000
fax: (605) 232-2023
Circle 1226 on Inquiry Card.

International Data Systems
(IDS450i2)
12800 Garden Grove Blvd., Building E
Garden Grove, CA 92643
(714) 530-8677
fax: (714) 530-0815
Circle 1227 on Inquiry Card.

NCR Corp.
(NCR System 3335)
Workstation Products Div.
1700 South Patterson Blvd.
Dayton, OH 45479
(800) 225-5627
(513) 445-2078
Circle 1228 on Inquiry Card.

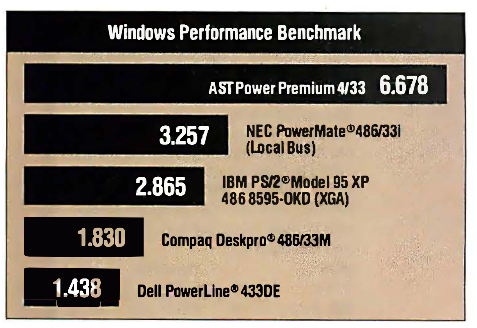
Northgate Computer Systems, Inc.
(Northgate Elegance ZXP)
Northgate Park
7075 Flying Cloud Dr.
Eden Prairie, MN 55344
(800) 548-1993
(612) 943-8181
fax: (612) 943-8336
Circle 1229 on Inquiry Card.

Tandy Corp.
(Tandy 4850 EP)
1800 One Tandy Center
Fort Worth, TX 76102
(817) 390-3011
fax: (817) 390-2774
Circle 1230 on Inquiry Card.

Zeos International
(Zeos 486DX2-50)
530 Fifth Ave. NW
St. Paul, MN 55112
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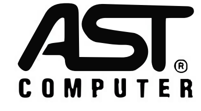
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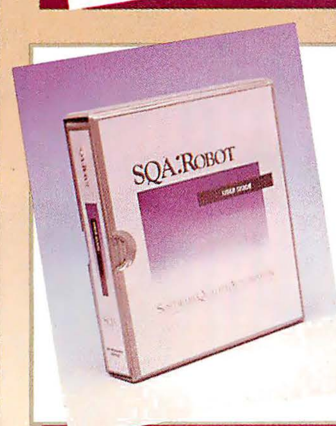


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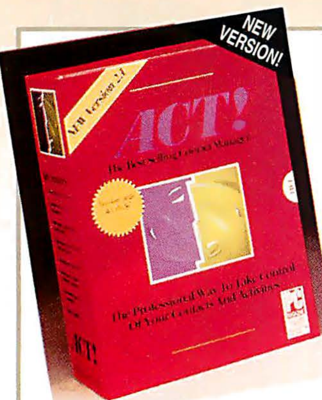


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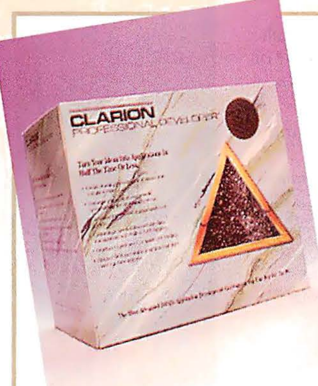


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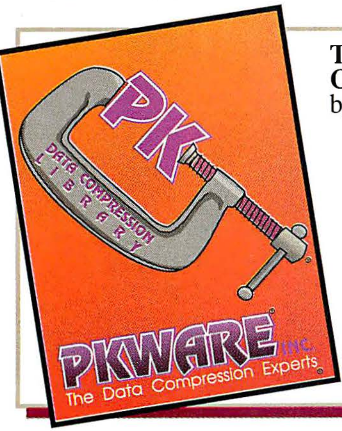


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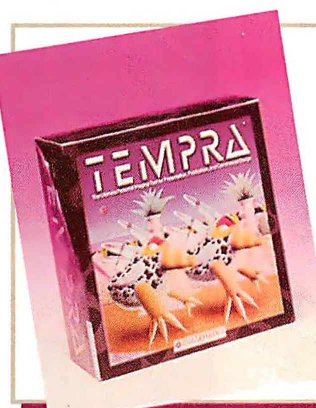


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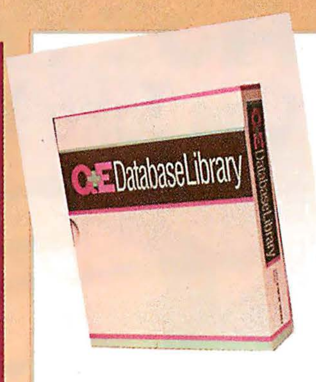
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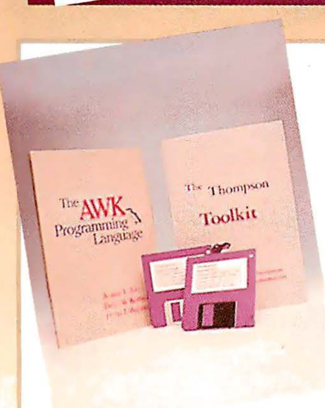
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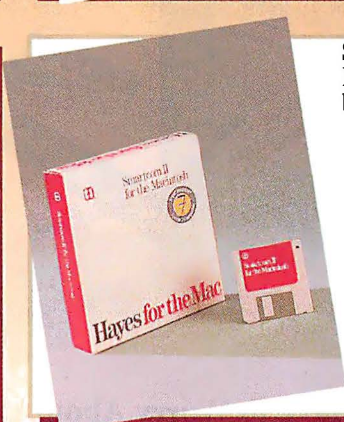


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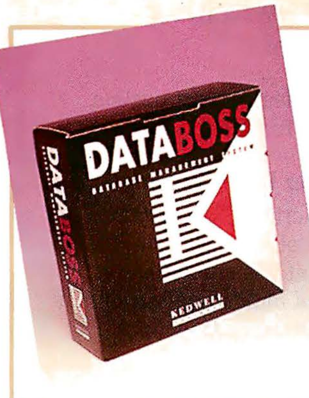
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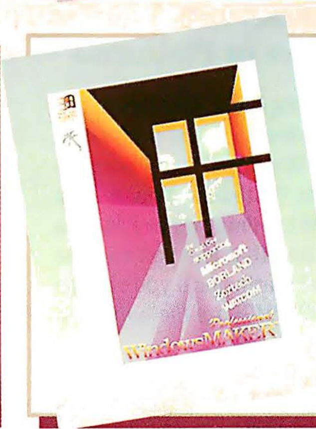
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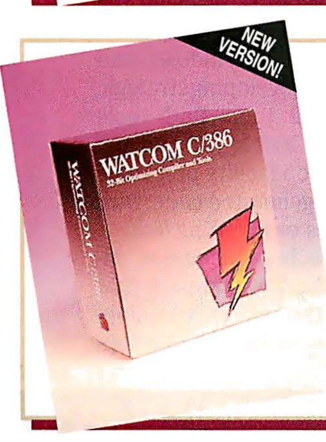
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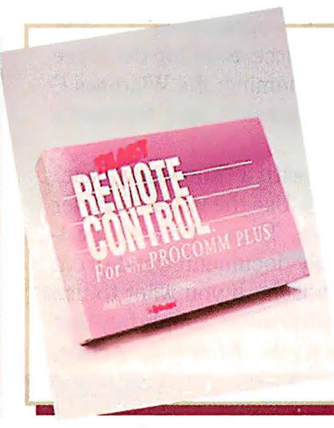
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APPLICATION

Borland Builds a Better Quattro Pro

ROBERT VANNATTA

Borland's nonstop flow of enhancements to Quattro Pro has resulted, with version 4.0, in a powerful spreadsheet product that continues to give DOS users a good alternative to Lotus 1-2-3. This new release has been improved with better printing features, faster font scaling, push-button operation, auditing functions, and network support. The program still doesn't let you have multipage worksheets, but you can group as many as 32 worksheets into a so-called workspace.

Quattro Pro has always been praised for its good-looking output, but with this new release, it's even better. Quattro Pro 4.0 comes with enough fonts to suit the needs of most spreadsheet users. But more significantly, the program now incorporates Bitstream's font-scaling technology, which is similar to Adobe Type Manager. Previous versions used a different Bitstream technology (Fontware), which was much slower at building screen fonts. (Version 4.0 can handle these older fonts, so you can use worksheets done with earlier releases and they will print out looking the same.)

Getting a spreadsheet to fit on paper is just as difficult as getting it to fit onscreen. Not everyone has a printer that can handle giant columnar paper. My trusty Texas Instruments 810 seven-pin dot-matrix printer still sits at my side, ready to mash a box of greenbar paper on a moment's notice; but these days, more often than not, it serves as a table to support my smallish NEC Pinwriter P2200. The latter is what Borland had in mind with the design of Quattro Pro 4.0. (Of course, support for numerous other printers is provided as well.)

When it comes time to print, the printer driver takes notice of how big your paper is and automatically scales the document down so it will fit on the paper. If you don't want to take your chances on an auto-scaling routine, you can set the scaling manually. This is particularly appropriate if you are printing several documents and you would like a consistent appearance. For "print to fit" to work, you need a printer that will print in graphics mode.

You can define custom styles for worksheets. Each style is a collection of attributes (e.g., type of font, shading, color, alignment, and numeric format) that you can then apply to an entire sheet or just to part of it. For example, if you want your totals to stand out from the rest of the page, you can set up a style for that; this might include a bigger type size and boldface print.

Quattro Pro 4.0's SpeedBar (below the standard menu line at the top of the screen) lets you activate operations, such as choosing a typeface, by pressing a button.

Quattro Pro 4.0 has a spooler that allows printing to be done in the background. The spooler isn't the greatest thing since sliced bread, but it works. I am used to the system spooler that runs smoothly in the background of Digital Research's Multiuser DOS, and I frankly found this one quite annoying, as its activity, which was nominally in the background, generated snow flurries on a CGA monitor; a selection in the screen options menu called CGA Snow Suppression is intended to prevent this flickering.

Analyzing with Graphics

In another enhancement to Quattro's already-considerable graphics facilities, Borland has added what it calls *analytical graphing*. Data series for a graph no longer need be just a column or a row of data; rather, the input series can now be defined as a moving average or an aggregate. Analytical graphing basically lets you look at data from different perspectives and then graph the results without changing the original worksheet.

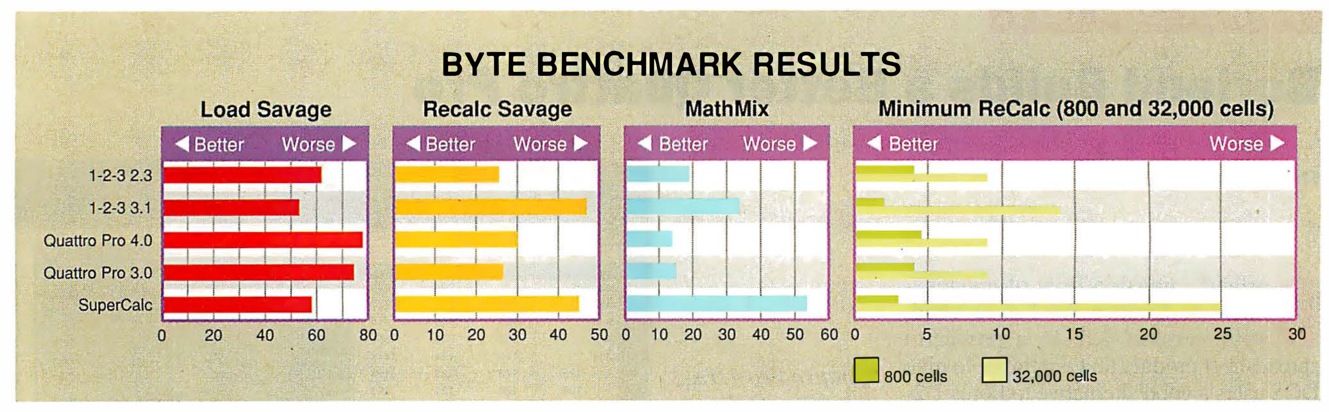
Suppose, for example, that your worksheet totals product shipments on a monthly basis, but you want to see them on a weekly basis. Quattro Pro will now let you examine and graph this information as a weekly series without changing the monthly series. After you've chosen the data you want to study, you then pick the type of analysis you want to apply. This new feature can save you from the time-consuming process of redoing an entire spreadsheet.

Getting Audited

In a somewhat overdue response, Quattro Pro now has an audit function, which is intended to help get the sheet right in the first place. The real tragedy of the audit function is that it is weakly implemented. It will produce a display of dependent cells and will ferret out blank, ERR (a cell containing an invalid formula), label, and circular references, as well as external links. While this compares favorably with the AUDITOR.ADN bundled with Lotus 1-2-3 release 2.3, it is sorely lacking when compared to the SuperCalc 5 audit facility. Missing features include orphan name and cell locators, as well as locators for named ranges and overlapping named ranges.

In an effort to prevent the errors in the first place, Borland has added a provision for documenting important parts of the sheet. You can add comments to range names, formulas, and graphs, among other things. Additionally, you can password-protect formulas; any action that would change a formula generates an error message.

It seems that there is no place for this extended information in the Lotus WK1 format, however. If you save in the WK1 format, your carefully conceived passwords and comments are stripped away without



Quattro Pro 4.0 performs almost identically to version 3.0. As a calculating engine, it's in the same class as its chief competitor, Lotus 1-2-3 release 2.3. The Savage tests measure floating-point operations. Load Savage determines the load time of a 320-row by 100-column spreadsheet. Recalc Savage measures recalculation speed. MathMix tests basic math operations. Minimum ReCalc determines if a program recalculates only the cells affected by a change or the entire worksheet.

BYTE ACTION SUMMARY

WHAT QUATTRO PRO 4.0 DOES
The latest version of Borland's spreadsheet program for DOS lets you calculate numeric data, sort data, and present results in a graphical fashion.

LIKES
Works well in tight memory spaces; transparent network operations; optional WYSIWYG mode; and fast font scaling.

DISLIKES
Weakly implemented audit function; doesn't handle multipage worksheets.

RECOMMENDATIONS
Users of 3.0, especially if on a LAN, should upgrade; DOS users looking for their first spreadsheet would do well to consider Quattro Pro.

PRICE
$495; LAN package (one user), $395

FOR MORE INFORMATION
Borland International, Inc.
1800 Green Hills Rd.
P.O. Box 660001
Scotts Valley, CA 95067
(408) 438-8400
fax: (408) 439-8050
Circle 1239 on Inquiry Card.

even a warning message.

Borland has added user-definable numeric styles to version 4.0. (SuperCalc users will point out that they have had them for 10 years.) The most useful thing about them is that you can attach a leading or trailing string to a number. For example, lumber merchants can define a numeric mask that will print with a trailing *M*, as in 100M.

Just Push the Button

For rodent lovers, the new Quattro Pro has what Borland calls the SpeedBar, which is a collection of push-button shortcuts. Instead of dragging down a menu to initiate a function, you just click on a button. The SpeedBar is similar to the button bars in Windows word processors and was called the mouse palette in previous versions of Quattro Pro.

Most of the SpeedBar buttons, which are available in both the character mode and the WYSIWYG mode, are for applying fonts and styles to text. But there's also a novel button that enters an @sum formula. This sum button lets you quickly get a total of columns and rows.

Progressive LAN Support

LANS are pandemic today, and Borland knows this. One of the things that I have found particularly pleasant about the Borland line of products is that they all have a consistent way of implementing LAN support; it is designed in, as opposed to being hung on.

The LAN features in version 4.0 are for Novell NetWare users (either NetWare 286 2.15c or higher or NetWare 386 3.1 or higher). Specifically, you can now log on to network file servers, map to volumes on those servers, print to print queues, and monitor a print queue from inside Quattro Pro. These network operations are transparent from within the spreadsheet program.

Borland uses a progressive LAN licensing approach, which requires you to have a license count equal to the number of users that will be active at any one time, irrespective of the size of the LAN. In other words, if you have 20 workstations, but only 10 people will be using the program at the same time, you need a 10-user license. During the installation, you pledge the appropriate number. The furnished metering software enforces the count and keeps users from walking on one another's files.

On a shared network directory, the first user to open a Quattro Pro file has read/write privileges to it. Other users can have read access to it and can make changes to it, but they can't then save the file with the same name in the same directory; trying to do so elicits a "sharing violation" error.

The LAN installation is well documented. My only complaint is that the metering software cannot tell a virtual user from an actual user. I ran into a problem here using Digital Research's Multiuser DOS. Each DRMDOS physical console supports up to eight virtual consoles. Consequently, if you are a power user and want to load several copies of Quattro Pro in as many virtual consoles on your terminal, you can do so, but the metering software counts each load as a user against your license count.

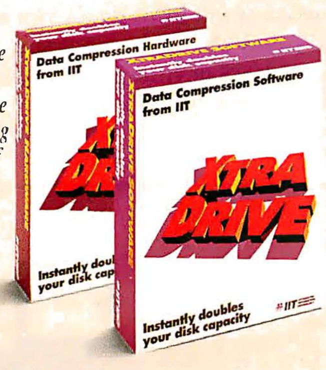
Mostly Lotus-Compatible

No spreadsheet review is complete without a few raves and brickbats over the issue of "compatibility." This is a tricky issue, because Lotus is currently marketing at least three spreadsheets that to some degree

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aren't compatible with each other. Historically, Quattro Pro has received high marks for Lotus compatibility, because it worked seamlessly with the file format associated with 1-2-3 release 2.01 (the WK1 format) and because it supported every feature of 1-2-3 release 2.01.

In one sense, you can argue that Quattro Pro is more Lotus-compatible than ever. In addition to its traditional grasp of WK1 files (1-2-3 release 2.x format), the program can also read the newer WK3 format (1-2-3 release 3.x and 1-2-3 for Windows). Additionally, it can read data in the ALL format (used by the Allways add-in), the FMT format (used by Impress), and FM3 (the 1-2-3 release 3.1 WYSIWYG format).

But the true "file format" of 1-2-3 release 2.3 is WK1+FMT, with the classic WK1 file holding the data and the primitive formatting information and the FMT holding the extended formatting information. According to this definition, bidirectional compatibility collapses, because Quattro Pro won't generate an FMT file.

Similarly, Quattro Pro provides "support" for the Lotus WK3 format, but, due to logical differences in the software, that support is limited. Quattro Pro will let you open a WK3 file (it opens it as a 2.x file), but if the file uses a feature specific to 1-2-3 release 3, Quattro Pro has to work around it. For example, if the 1-2-3 file contains multiple spreadsheets, Quattro Pro loads them in as separate files. The program converts references to three-dimensional blocks to complex formulas. Quattro Pro will not convert references in macros. Graphing features unique to release 3 are not supported at all.

Besides Lotus formats, including Symphony, Quattro Pro 4.0 can handle files from Paradox, dBase, Reflex, Harvard Graphics, SurPass, VisiCalc, and Multiplan.

Performance Stays the Same

No significant performance enhancements are evident in Quattro Pro 4.0. BYTE Lab benchmarks indicate that this new release runs on a par with 3.0 (see the figure). In terms of recalculating speeds, Quattro Pro remains comparable to its rival, 1-2-3 release 2.3. Quattro Pro 4.0's calculation performance slows down in WYSIWYG mode, so you might want to work in character mode and switch to WYSIWYG only to check graphs and other visual elements.

Conservative users of Quattro Pro will be relieved to know that the core of their favorite spreadsheet is very much the same, even though it may look a little different. Version 4.0 brings strong NetWare support, outstanding style and formatting features, a print spooler, improved font building, and SpeedBar buttons. Places to insert comments and a rudimentary audit function should make the sheet more reliable. The program's failure to recognize and exploit large amounts of expanded memory, and the lack of support for multiple logical sheets within a single physical file, remain serious negatives for power users.

For the DOS user who wants a Lotus-compatible spreadsheet that performs well on low-end PCs, has good graphics capabilities, and produces sharp-looking output, Quattro Pro is an excellent choice. ■

Robert VanNatta is an attorney in St. Helens, Oregon. His office uses a single 33-MHz 486 computer running Digital Research's Multiuser DOS and supporting six terminals. He moderates the spreadsheets conference on BIX, where you can reach him as "rvannatta."

APPLICATION

Arago Raises the Xbase Ante

MARC SCHNAPP

There's a new dark-horse candidate in the Xbase race. With Borland's takeover of dBase and Microsoft's acquisition of FoxPro, Xbase—now enshrined as the PC database community's preferred development environment—looked like it could become a two-party system. But there's a new entry in the race: Wordtech Systems, with its dBase IV–compatible Arago.

The Arago product family consists of dBXL, an interactive environment, and Quicksilver, a compiler. The two are available as a bundle called Arago Professional. Both products rest on the same code base; this makes Wordtech the only vendor to have released a coordinated dBase IV interpreter and an .EXE compiler.

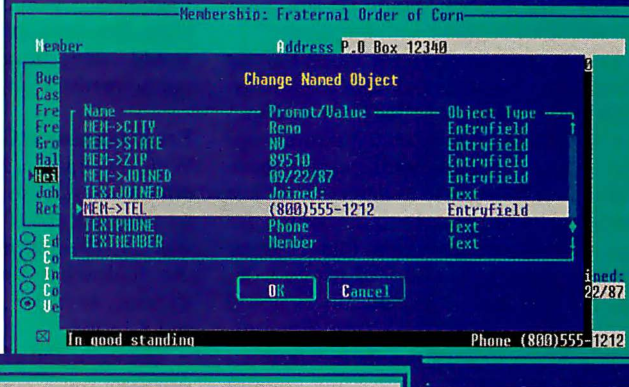
Wordtech Systems has produced several releases of dBXL and Quicksilver, but Arago is built on a reformulated code base. It's highly compatible with dBase IV but sports a more modern user interface that follows IBM's CUA (Common User Access) guidelines (see screen 1). Plus, Arago has language extensions to enable developers to create simple event-driven applications.

According to initial performance tests, the product line offers speed comparable to that of FoxPro 2.0 and outpaces dBase IV, while providing a better user interface paradigm than either of its DOS-based competitors.

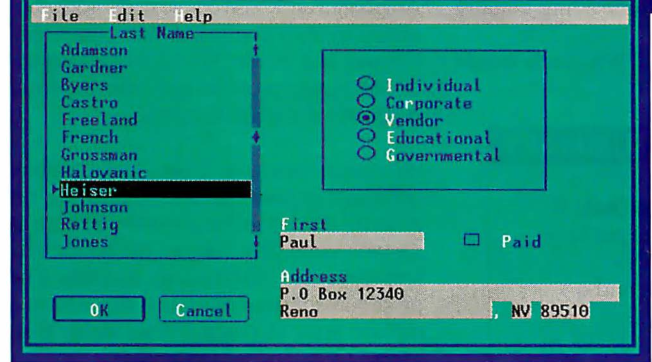
Arago builds applications with a series of character-based panels. A panel is a rectangular frame onto which you place screen objects, such as pull-down menus, list boxes, radio buttons, check boxes, browse tables, and scrolling text editors.

Wordtech's designers have devoted considerable effort to usability and friendliness. On machines with EGA or VGA cards, Arago replaces several of the standard characters on your video card with custom fonts. As a result, Arago presents you with round radio buttons and push buttons and square check boxes.

Although Arago supports the dBase IV windowing syntax, you get the same static objects you'll find in dBase IV 1.5. Wordtech does not adopt FoxPro's more robust event-driven windowing. FoxPro handles window access as events; you can click on any live window at will, and it gains focus. Arago and dBase IV windows



Screen 1: *Although character-based, Arago follows CUA guidelines to present you with an interface that looks more modern than those of some competing products.*



Screen 2: *Arago's Panel Painter lets you test the behavior of screen objects. If you attach code to a panel, the Panel Painter will execute the code when you trigger the related event.*

are accessible only through explicit calls in the source code. Because the behavior of Arago windows is relatively limited, the product lacks a raft of window query functions (e.g., WVISIBLE( ), WONTOP( ), WCHILD( ), and WEXIST( )). Although Wordtech did not invest its efforts in advanced windowing technology, the company dedicated considerable attention to the behavior of panels. Each panel has its own context, and the objects placed on a panel participate in that context. The panel syntax is borrowed largely from dBase IV's windowing language. Pull-down menus use identical syntax, while list boxes are inherited from dBase IV pop-up menus.

Panel Painter's Productive

Arago proves that visual programming can work in a character-based environment. By permitting you to test the behavior of screen objects, Wordtech's Panel Painter (see screen 2) transcends FoxPro's screen builder. Place a list box on a new panel, and you can immediately test the panel's refresh behavior. Attach code fragments to a panel, and the Panel Painter will execute the code when you trigger the appropriate event.

The benefits derive from the intelligence of Arago's underlying CUA design. Rather than treat check boxes and the like as picture format clauses (the way FoxPro does), Wordtech treats them as discrete objects, each one accorded its own declarative command. This is not only expedient in the short term; as Xbase acquires object-oriented features, these constructs will be more amenable to attached methods and complex event handling.

The Panel Painter is written in Xbase code using Wordtech's language extensions. It's provided as a pseudocompiled object file. Having to write a design utility at such a high level has its trade-offs. The Panel Painter is not as speedy as I'd like it to be. Making changes to any characteristic of the underlying panel results in a significant wait while Arago thrashes the disk. The Panel Painter maintains a data file with multiple memo fields. All the design parameters for every aspect of the panel are written to and read from the file. Although Arago's disk I/O performance is close to FoxPro's, Wordtech's Panel Painter must also compile and interpret the code it encounters.

Limitations of the underlying product constrain the Panel Painter's ease of use.

continued

You can manipulate items with the mouse, for example. But once you lay an object down in a panel, you have to press a key or two to trigger modifications. You can then use the mouse to drag or resize an item, but you must conclude by pressing the Enter key. The process would be smoother if it could all be done with the mouse.

Despite rough edges, the Panel Painter contributes mightily to Arago's usability. Although FoxPro benefits from its superior windowing and thorough mouse support, I still find the Panel Painter more productive. Being able to interactively test the behavior of a panel minimizes the design effort significantly. The Panel Painter demonstrates the viability of Arago's design. If Wordtech's programmers could fashion this application using the company's Xbase extensions, there's nothing stopping a customer from doing equally clever things.

It would be a plus if Wordtech would provide Panel Painter source code to Arago customers. I'd like to modify some aspects of the utility—and the code would serve tutorial purposes. Wordtech does furnish a 98-KB source file for a calendar utility. There's fertile ground here for refinements. I would vote for a good template-directed application generator. This would satisfy developers' customization requirements.

BYTE ACTION SUMMARY

WHAT ARAGO PROFESSIONAL IS
An Xbase development package consisting of a dBase IV–compatible interpreter and a compiler.

LIKES
Coordination of interpreter and compiler, user interface, Panel Painter, preprocessor, dBase IV compatibility, and Xbase extensions.

DISLIKES
Lack of window query functions; no multiuser version (yet).

RECOMMENDATIONS
Arago Professional is a solid database development package, but you should probably wait for the multiuser version.

PRICE
Arago Professional, $1199
Arago dBXL, $699
Arago Quicksilver, $799

FOR MORE INFORMATION
Wordtech Systems, Inc.
21 Altarinda Rd.
Orinda, CA 94563
(510) 254-0900
fax: (510) 254-0288
Circle 1223 on Inquiry Card.

Preprocessor a Good Addition

With little fanfare, Wordtech began shipping a 2.1 release one month after Arago's introduction. The most notable change was a C-like preprocessor. It recognizes the following directives: `#define`, `#ifdef`, `#ifndef`, `#include`, `#pragma`, and `#undef`.

The inclusion of a preprocessor brings Arago into an Xbase clique heretofore populated by two command-line compilers: Clipper and Force. By adding a preprocessor, Arago provides mainstream Xbase programmers with new options:

•*Manifest constants*: Xbase lacks explicit constants as found in other languages; ordinarily, the programmer defines these as variables and then follows the honor system to prevent overwriting constants. The preprocessor uses `#define` to perform a replace prior to compile time rather than assign literal values to variables.
•*Conditional compilation*: By bracketing code segments with `#ifdef` or `#ifndef` and an `#endif` directive, developers provide control statements respected by the compiler. This makes it handy to create test versions of systems and to maintain code with multiple dialects of Xbase. One common use is to embed controls for crippled demonstration versions of vertical-market packages (see listing 1).
•*Pseudofunctions*: These are commonly known in C as macros. But Xbase already has a macro construct, used to expand variables. Pseudofunctions create custom functions by conglomerating existing functions in the Arago run-time library:

```
#define ALLTRIM(x)
   (RTRIM(LTRIM(x)))
#define MAX3(x,y,z)
   (MAX(MAX(x,y),z))
```

The preprocessor gives Arago programmers benefits long taken for granted by C programmers, such as ease of reconfiguration, reduced symbol-table size, and faster processing (constants can be processed more rapidly than variables). The addition of a preprocessor also brings case sensitivity to Arago. Programmers must observe the same usage within the body of a program's code as they did when using the `#define`.

Mixed-Language Development

Wordtech is making a naked bid for the favor of Clipper developers with Arago's support for mixed-language programming via Clipper's Extend/Extor API. Primarily used by C programmers, the interface presents functions for passing values to and from Arago. The interface has proven an extremely popular entry point for third-party library products in the Clipper world. Wordtech currently supports Microsoft C. (Arago was written in Microsoft C 6.0.)

Clipper developers migrating applications to Arago won't initially have a stack of immediately usable Clipper libraries because of the following factors: A high proportion of Clipper libraries make use of internal Clipper constructs to gain speed or to implement features not otherwise possible. Arago does not include or emulate Clipper internals. Although Clipper permits its libraries to mix C object modules with those compiled from Clipper source code, Arago does not support all Clipper functions. For example, Arago lacks the Clipper array-handling functions: `asort()`, `aadd()`, `ainsert()`, `ascan()`, `afill()`, `afields()`, `adir()`, `adel()`, `acopy()`, and so on.

As of press time, Wordtech has certified two graphics libraries: dGE (Pinnacle Publishers) and dGT (BlackHawk Systems). A major general-purpose Clipper library, FUNCky II, is in final test phase. The prospects for lengthening this list are largely dependent on Arago sales and inducements to third-party developers.

Writing Reports with R&R

Wordtech bundles Arago with R&R Report Writer from Concentric Data Systems. That turns out to be a good thing, because R&R is the best report writer for Xbase and may very well be among the best ever offered for databases.

The dBXL interpreter comes with R&R's interactive report maker. Quicksilver comes with Concentric's code generator. The latter reads report binaries and turns them into Arago Xbase programs. Both are a version behind the current retail release. Users who want advanced printer drivers with proportional font support should consider upgrading to R&R 4 for $99. This version supports the formats created by the broader array of Xbase products: Clipper, dBase IV, and FoxPro.

The report writer rates well on its own for ease of use. The product guides you through the steps of joining Xbase files and filtering data sets. You place fields on a semi-WYSIWYG banded report surface.

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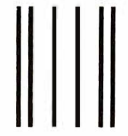
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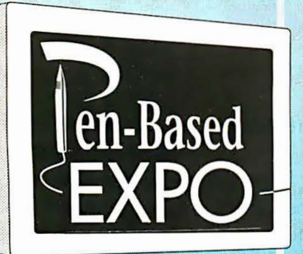
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The R&R interface has nothing in common with Arago's. Concentric based its hierarchical access system on the Lotus ring menu with bounce bars. People familiar with Lotus 1-2-3 will take to R&R with dispatch, while others may take a bit more of a nudge. Developers will find this easy sledding.

SmartCode Generator

The Arago package comes with a template-directed code generator that the publisher calls SmartCode, an OEM version of SoftCode (marketed as an Xbase add-on). It too presents its own user interface—and an idiosyncratic one at that. The provided templates produce a fairly generic form of Xbase code; there's no acknowledgment of Arago features and no explicit support for dBase IV window commands.

The strength of this template-directed system lies in its openness to modification of the code generator, so interested developers could easily write slicker templates than those provided. But developers who plan to exploit template systems would be wise to evaluate three superior commercial alternatives: UI2 (from Template Garden), Stage (from IS Technologies), and Scrimage (from Synergy). While only UI2 promises Arago templates in the near term, the latter two publishers say they'll add Arago support following Wordtech's release of a multiuser version.

Debugging and Testing

Arago offers several tools for the testing and debugging process. First, there's the Fix option. When the dBXL parser encounters errors during the pseudocompile operation, dBXL will optionally load its text editor with the cursor on the offending source line. This feature works nicely for eradicating simple typing errors and obvious logical flaws.

When you issue the SET COVERAGE ON command, Arago monitors any control structures encountered. You exercise the application, and Arago reports which blocks have and haven't been tested, along with the percentage exercised in your test. This thoughtful addition ought to improve quality control considerably.

The debugger does not match Clipper's very powerful implementation, but it comes close to that of FoxPro. You're presented with a window with three columns. Place an expression in the first column for Arago to evaluate. If you want to inject a breakpoint, you submit a Boolean expression and check the breakpoint check box in the second column. (A "hide" push button unclutters the screen. If it encounters a breakpoint, Arago redisplays the debugger.) The third column shows results. The debugger can be invoked from within a program, but you can supply expressions only by typing them in.

Arago displays source code in a window, permitting you to step through troublesome code. The usefulness of this feature is hobbled due to its narrow viewing area. While I can conceive of referring to the window for context, there's insufficient information to keep you fully informed. By placing the screen in 43- or 50-line mode, you can place the debugger and source viewer below typical 25-line applications. I'd still like to move these objects with the mouse at will. However, Arago does permit you to drag them using keystrokes.

Quick Linking

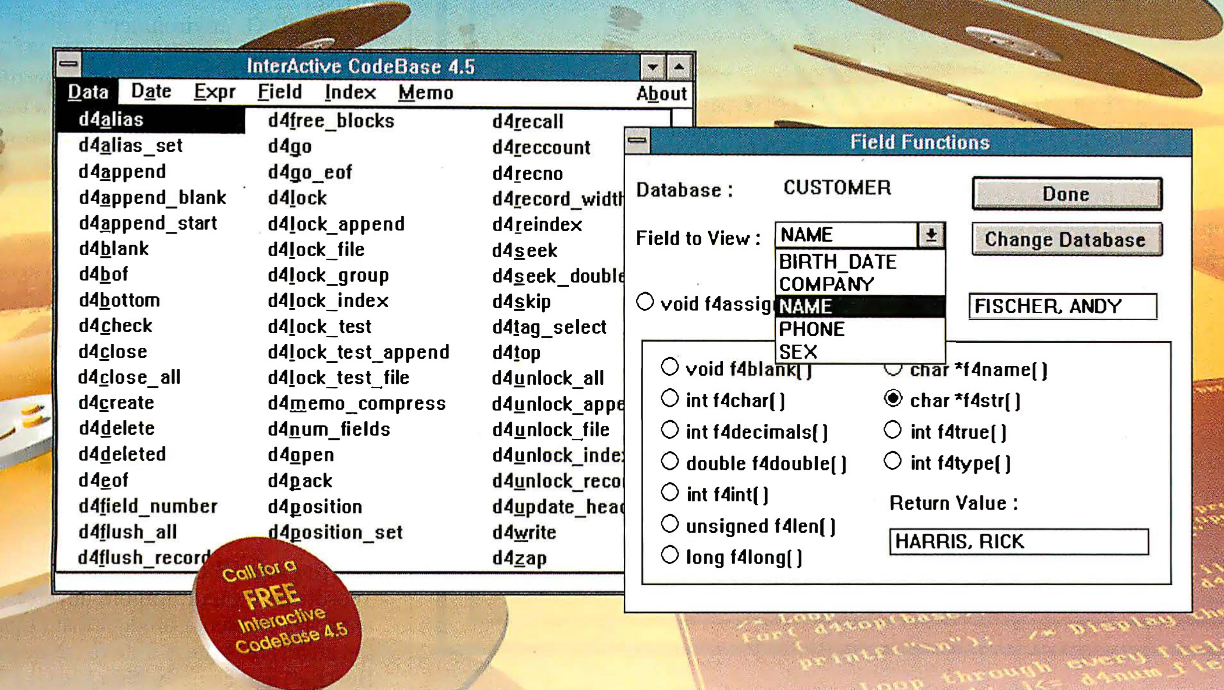
Wordtech learned from its clumsy past attempts to synchronize its interpreter and compiler, which were based on two different code bases relying on two different

Listing 1: *Conditional compilation makes it easy to develop demonstration versions of vertical applications.*

```
#define DEMONSTRATION && Comment this line when compiling
   && a Professional version
#ifdef DEMONSTRATION
 #define MAX_RECORDS 1000
 #define GREETING "ABC Accounting Demonstration Version"
#else
 #define MAX_RECORDS 1000000
 #define GREETING "ABC Accounting Professional Version"
#endif

CLEAR
? GREETING
USE ABC
IF RECCOUNT() > MAX_RECORDS
 ? "You may not add any more records."
ENDIF
```

dBASE, FoxPro and Clipper in C, C++ and Basic



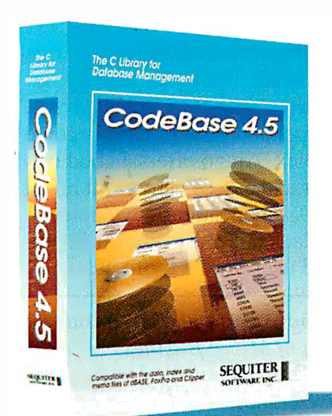
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ARAGO RAISES THE XBASE ANTE

compilers. This time the two products are well in hand. The Quicksilver compiler accepts either ASCII source .PRG files or the intermediate .PRO files crunched by dBXL.

The dBXL environment supports link libraries with its SET LIBRARY TO command. Libraries designed for use by dBXL require that developers include a header and structure pointing to any contained routines that the dBXL programs are going to call. QuickLink is an OEM version of OptiLink (from SLR Systems), a reasonably fast linker that uses EMS or XMS (Extended Memory Specification) to cache operations in linking Quicksilver applications (QuickLink also observes the TMP environment variable for RAM disks). Following the path blazed by Blinker and WarpLink, this linker creates dynamic overlays for Xbase code. While it is not quite as speedy as those two competitors, QuickLink is the fastest linker I've yet seen bundled with an Xbase product.

Outpacing dBase

Wordtech's small, nimble development team has created a product that outpaces the efforts of Ashton-Tate (as digested by Borland) and comes within a hair of FoxPro's performance. The lack of a multiuser version limits Arago's appeal in the short term (although Wordtech promises a LAN edition in the next few months). Most file server–based DBMSes bog down when subjected to LAN operations; it will be interesting to see whether Arago offers better performance in this respect.

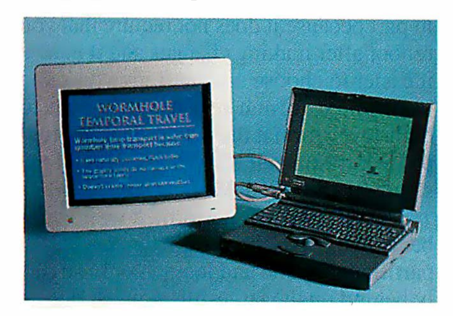
Arago shows thoughtful design. Given sufficient market interest, it should mature in subsequent versions with improved windowing, fuller mouse support, array-handling functions, and additional preprocessor directives. But developers will be far less patient in awaiting a network version.

Savvy Xbase developers once latched onto FoxBase+ as a means of speeding up dBase III Plus systems. Arago could inherit this role in the realm of dBase IV. There's also the attraction of royalty-free .EXE files and the ability to rapidly develop applications with the CUA interface.

While Clipper and FoxPro have become rich but complex, Arago offers a good balance of power and ease. There's still life in text-mode DOS applications development. What Arago lacks, it makes up for in performance and user productivity. ■

Marc Schnapp is a database consultant and president of Micro Business Services (Flushing, NY). He is involved in the quest for an Xbase standard. You can contact him on BIX c/o "editors."

Mac PowerBook Color Output



For the Macintosh user who needs portable computing power, Apple's notebook computers—the PowerBook 140 and 170—satisfy most needs, with one glaring exception: They lack a video output port to drive displays larger or brighter than the PowerBook's built-in LCD screen. Such a display is a requirement for product demonstrations or business presentations.

Envisio provides an elegant solution. Its 030 Notebook Display Adapter plugs into the PowerBook's internal memory slot. On the outside of the PowerBook, a standard Apple DB-15 video output connector mounts on the LCD screen's hinge. Because 32-Bit QuickDraw is built into the 68030-based PowerBook firmware, you can get color output on the external monitor. The board supports a variety of displays, such as Apple's own 13- and 16-inch monitors and VGA monitors. However, because the NDA allocates a fixed-size frame buffer in main memory, the larger the external monitor, the fewer colors you'll have available.

If you've already plugged additional memory into the PowerBook's memory slot, the NDA has a slot that lets you piggyback existing memory on the board. You can also purchase NDAs that provide an additional 2 or 4 MB of RAM.

Installing the board and mounting the connector require lots of technical verve, size 8 and 10 Torx drivers, and taking the PowerBook apart. The preliminary DB-15 video connector has only the bare circuit board and looks scruffy; a well-designed plastic hood that covers and protects the connector is in the works, according to the company. In the BYTE Lab, I installed a 2-MB 030 NDA in a PowerBook 170, but the job is best left to your Apple dealer. I got 256 colors on an Apple 13-inch monitor and 16 colors on an Apple 16-inch monitor.

The extra 2 MB of RAM was welcome for regular work. Graphics software such as Adobe Photoshop 2.0 worked, as did Aldus FreeHand 3.0. The top two presentation packages, Microsoft's PowerPoint 2.01D and Aldus's Persuasion 2.0, also worked fine. However, Adobe Illustrator 3.2 got cranky, sometimes crashing at launch. Occasionally the default color palette would get munged while running either PowerPoint or Persuasion. This appears to be a problem with either the Envisio driver or the PowerBook's firmware.

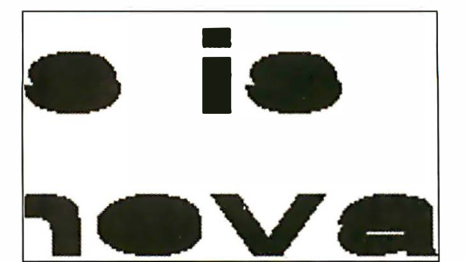
If you need color output from your PowerBook, the Envisio 030 NDA is a good solution. If possible, before you buy it, check it out with the applications you plan to run. Also, if your budget permits, purchase one with extra memory (the 2-MB 030 NDA is $1195, and the 4-MB 030 NDA is $1595).

Hatch Your Own Fonts

Sometimes a font just does not look right. It's too thin or too thick. You've got to create a really bold headline, and the Bodoni Bold on your system just isn't bold enough. You could buy a new set of fonts. Or you could learn a font-design program like Altsys Fontographer. Or you could try The Incubator.

This new $149.95 Macintosh program from Type Solutions lets you manipulate the look of TrueType fonts. Working in what's called the Control Window, you can play with the type to get the look you want. The Incubator will change four basic aspects of a font: width, contrast (thickness or thinness of thin parts in contrast to thick parts), slant, and what Type Solutions calls color (lightness and heaviness).

You adjust these attributes either by moving sliding control bars or by typing in numeric values. As you make the adjustments, you can see the type change in the window. All you have to do is keep adjusting until the characters look the way you want. Then you give the font a name (e.g., Bodoni Bolder) and shuttle it into your System folder. It will then appear under the regular Font menu.



You've got to check all the characters in an incubated font before using them in an application.

The Incubator is extremely easy to use. You can cook up a new font in a few minutes. The problem is, the font might not work at certain point sizes, or certain letters might be defective. For example, a font that looks fine in The Incubator might not look so great when you use it in your word processor. There's a tendency with really heavy styles to fill in the holes of a letter; an *o*, for example, can come out looking like a solid object rather than a donut. You can't see this when you're working in the Control Window, so you may get surprised when you try to use an incubated font in an application. At the risk of making the program harder to use, Type Solutions should give the user more control of the finer points of fontmaking, or at least make the program smart enough to warn you that the attributes you've chosen won't work at certain point sizes.

The Incubator is a great idea, particularly in light of all the action with TrueType. (Type Solutions realizes that the biggest gang of TrueType users will be people running Windows 3.1, so the company smartly has a version of Incubator for Windows in the works. It could be out by the time you read this.) But this font hatcher could have used a little more time in the oven.

—The BYTE Lab

Sony's Retail Entry Shows Promise

Editor's note: *Due to a printing error, some information was deleted from David Harvey's text box "Sony's Retail Entry Shows Promise," which appeared in the May comparison of 3½-inch magneto-optical drives (page 240). What follows is that text box in its entirety.*

At press time, Sony planned to sell the RMO-S350 drive under its own name to retail customers, which would make it one of the first commercial magneto-optical (MO) products from Sony. I was able to evaluate an early version of the drive and beta versions of associated software and found this to be a solid package.

The drive came in a sturdy metal case with a removable fan filter, a ground terminal, dual SCSI ports, and a bank of DIP switches to set drive address, termination, parity, termination power, automatic spin-

up, and manual-eject enable. The plastic front panel had the usual power LED, drive LED, manual-eject, and automatic-eject mechanisms.

The controller card included in my early version was a 16-bit Adaptec 1520 with internal and external SCSI connectors and jumpers for interrupt-request, DMA, and BIOS address manipulation.

The beta version of Sony's RMOS utility software appeared to be designed from the ground up to work with removable optical media. While it does not have the universal functionality of Columbia Software's SST or CorelDriver, it offers a host of removable-media-specific options and was the best suited to deal with 3½-inch MO drives.

One useful feature is that the RMOS Macintosh drivers support Apple File Exchange. As a result, you can create and use DOS partitions on Macs, allowing you to exchange files, up to 12 MB in size, between the two platforms.

The menued RMOS utility delivers most basic media-manipulation tools, including partitioning, low-level and high-level formatting, defect management, and a utility that lets you analyze a disk's format mode. RMOS promises to be very easy to use, in part because it does not require that you reboot after making changes and it makes it easier to choose among floppy disk and partitioned format modes. Note that to high-level-format the RMO-S350 in floppy disk format, all RMOS does is call the standard DOS FORMAT utility.

The RMO-S350 performed well in the benchmark tests, hanging with the pack in partitioned mode and lagging only slightly behind on the large-file move in floppy disk mode.

At press time, the suggested retail price of the Sony-branded RMO-S350 was $2295. General retail distribution is slated for early June. Overall, this package shows a lot of promise for its multitude of formatting options, as well as the intelligence of the software. ■

Reviewer's Notebook provides new information—including version updates, new test data, long-term usage reports, and reader feedback—on products and product categories.

ITEMS DISCUSSED

Notebook Display Adapter 030 ....$795
2 MB extra memory $1195
4 MB extra memory $1595
Envisio, Inc.
510 First Ave. N, Suite 303
Minneapolis, MN 55403
(612) 339-1008
fax: (612) 339-1369
Circle 1221 on Inquiry Card.

The Incubator $149.95
Type Solutions, Inc.
91 Plaistow Rd.
P.O. Box 1227
Plaistow, NH 03865
(603) 382-6400
fax: (603) 382-4839
Circle 1222 on Inquiry Card.

RMO-S350 ....$2295
Sony Corp. of America
Computer Peripheral Products Co.
655 River Oaks Pkwy.
San Jose, CA 95134
(800) 352-7669
Circle 1238 on Inquiry Card.

BOOK
AND CD-ROM REVIEWS

HUGH KENNER

BLEEPERS OF THE GATES

Accidental Empires
Robert X. Cringely

Hard Drive
James Wallace and Jim Erickson

Though you're 36, your voice sometimes cracks, dandruff is remarked on, and the Feds have an antitrust investigation going. Yet (based on stock holdings) you're a multibillionaire, and no company has ever touched billion-dollar sales per annum as fast as yours did, and you drive cars awfully fast and have been known to talk too frankly to the wrong people, who concur in putting your effective age at perhaps 14, and—well, you mustn't complain if you draw scandalmongers' attention. Bill Gates, founder and chairman of Microsoft, began drawing it last year. Hence two books.

"Robert X. Cringely" is the name signed to *Accidental Empires*, subtitled *How the Boys of Silicon Valley Make Their Millions, Battle Foreign Competition, and Still Can't Get a Date.* A wickedly fast read, it's dedicated to Pammy, "the woman of my dreams," which hints that Cringely, anyway, can get a date. He can also get a blurb from Adam (*Money Game*) Smith: "...lively, breezy, and informative."

That's a confluence of spooks. It's not wholly secret that "Adam Smith" hides the identity of George J. W. Goodman, novelist and entrepreneurial dabbler, or that "Robert X. Cringely," *InfoWorld* gossip columnist, is known to the IRS as Mark Stephens, *InfoWorld* senior writer; moreover, that there is no Pammy. None of which would matter save that the fine book Stephens conceived got botched by "Cringely." Keeping a mocking "insider" persona going needs Swiftian skills not commanded by a writer whose sole way of evoking Bill Gates is to typecast him as a snotty nerd.

Not that the book's about Gates, although his prominence earns him a giant helping of index entries. It's about the nigh-inadvertent rise of the microcomputer industry, and Stephens does have a deft way with farcical narrative. The story is far from complete—Philippe Kahn and Borland, for instance, are totally absent—but as a pencil rough, *Accidental Empires* passes nicely.

Read it, yes; but balance it with *Hard Drive*, a biography of Gates by two reporters at the *Seattle Post-Intelligencer*. It's by no means worshipful—the publisher hints at attempts to suppress it—but it does engage your sympathy for a man whose gifts, from an early age, so outran his social intuition as to make him an easy target for one-liners. ("Imagine an extremely smart, billionaire genius who is 14 years old and subject to temper tantrums"—a former Microsoft project manager.)

"In mathematics," Gates once said, "you develop complete characterizations, and you have to combine theorems in very nonobvious ways." He was talking about a link with programming; and he'd scored a perfect 800 on the math portion of his college boards. And he had an uncanny gift for seeing what needed doing next: When the pioneer MITS Altair was announced in 1975, he saw at once that what it needed was a BASIC interpreter. Moreover, unlike some 50 other people, he and Paul Allen proved capable of writing one, in 4 KB of memory, and without an Altair to test it on.

What (1992) needs doing next? Perhaps a hardware-independent standard. That's easily reworded as Microsoft Dominating Everything. Windows fits in here; it's finally tractable by version 3.1. (The need to get there first has mired Microsoft in part-done versions of many packages.) Give Gates credit for his vision. It's easy to shift your eye from the billions to a neon sign saying GREED. But (speaking of uniform standards) aren't you grateful that the clutch-brake-gas pedals are in left-to-right order on all cars? ■

Accidental Empires, Robert X. Cringely, Addison-Wesley, 1992, $19.95, 324 pp., ISBN 0-201-57032-7.
Hard Drive: Bill Gates and the Making of the Microsoft Empire, James Wallace and Jim Erickson, Wiley, 1992, $22.95, 419 pp., ISBN 0-471-56864.

Hugh Kenner is Franklin and Callaway Professor of English at the University of Georgia. He can be contacted on BIX as "hkenner."

THE AMERICAN PROGRAMMER

The Decline and Fall of the American Programmer, Edward Yourdon, Simon & Schuster, 1992, $24, 320 pp., ISBN 013-203670-3.

Is a cataclysmic disaster awaiting American programmers? Absolutely, says CASE expert Edward Yourdon in *The Decline and Fall of the American Programmer*. This book paints an alarming picture of an American software industry unable to compete in its own backyard. It might not happen tomorrow, but Yourdon foresees a gradual loss of market share, until one day American programmers wake up and exclaim, "My God! We've got a code trade deficit!"

After two doomsaying chapters, Yourdon goes on to offer hope. All is not lost. The solution is simple: Hire qualified, professional people; train them; provide tools and leadership; view the design, development, and maintenance of your software process as part of the overall power of your corporation; and do what you say.

Wow! Isn't this just a rehash of what we've been hearing from quality preachers such as Deming and Juran? Is this nothing but an ad for the Software Engineering Institute? This is nothing new—nothing revolutionary.

More than an instructional guide, *The Decline and Fall of the American Programmer* is a sledgehammer reminding you over and over there are no silver bullets. No high quality, just a lack thereof.

View this book as a Tom Peters–style search for excellence in the software world. Be prepared to be angered. Be prepared to be confronted. Be prepared to change.

—Raymond GA Côté

ILLUSTRATION: MIKE QUON © 1992

AI ENCYCLOPEDIA

Encyclopedia of Artificial Intelligence, 2nd ed., Stuart Shapiro, ed., Wiley-Interscience, 1992, $275, 2584 pp., ISBN 0-471-50307-X.

T*he Encyclopedia of Artificial Intelligence* is a comprehensive two-volume reference work that provides AI researchers with the practical underpinnings to theoretical discussions. My review started with a search through the field of machine vision. My exploration immediately pointed out why this encyclopedia includes a comprehensive index—it has no "vision" entry in the main text. Vision is such an all-encompassing field that a simple entry for it would solve nothing. Instead, head for the index and find: vision—AI, cognitive, color, commonsense reasoning, early, episodic memory, epistemology, high-level, Hough transforms, understanding, low-level neural networks, visual cortex, motion analysis, research issues, three-dimensional feature correspondence...you get the idea.

Three hours later, I returned from my journey after exploring the pros and cons of various character-recognition strategies. Similar adventures await me in speech processing, natural-language understanding, neural networks, expert systems, commonsense knowledge, and robotics.

At $275, this is not a book for the casually interested. However, no serious student or practitioner of any aspect of AI should be without this encyclopedia.

—Raymond GA Côté

PROGRAMMING QUICKDRAW

Programming QuickDraw, David Surovell, Frederick Hall, and Konstantin Othmer, Addison-Wesley, 1992, $26.95, 424 pp., ISBN 0-201-57019-X.

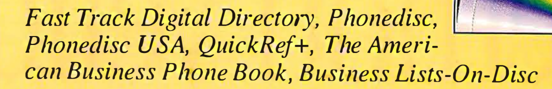
One problem that aspiring Mac programmers face is the paucity of good books on the subject. The hardest part of Mac programming is understanding the QuickDraw graphics engine. Since everything that appears on-screen is the result of QuickDraw operations, the neophyte programmer must wade through—and comprehend—dozens of QuickDraw definitions and traps before writing even a single line of code.

Help has arrived in the form of *Programming QuickDraw*. This book, with its broad coverage of both "classic" black-and-white QuickDraw and Color QuickDraw, goes a long way toward filling the QuickDraw information gap. The book's main focus is color—justifiably so, since it's a complex topic. It contains a description of the Palette Manager's palette tables that actually makes sense. Experts will find information on QuickDraw bottleneck procedures, how to replace QuickDraw's color search routines with your own custom routines, performing basic color separations, and other advanced topics. The authors cover the creation, care, and feeding of PICT images, including the new Picture Utilities in System 7.0. They augment this wealth of detail with copious code examples throughout the book.

I read the book from cover to cover, and it now resides on my bookshelf next to the *Inside Macintosh* volumes. *Programming QuickDraw* is a must for the Mac programmer.

—Tom Thompson

AMERICA ON CD



Fast Track Digital Directory, Phonedisc, Phonedisc USA, QuickRef+, The American Business Phone Book, Business Lists-On-Disc

Like encyclopedias and atlases, electronic telephone directories are a natural CD-ROM application. A few CDs replace stacks of telephone books, and quick searches save time.

The Fast Track Digital Directory (Nynex Corp. Church Street Station, P.O. Box 3518, New York, NY 10277, (800) 338-0646) and Phonedisc (Digital Directory Assistance, 5161 River Rd., Bethesda, MD 20816, (301) 657-8548) offer "white pages" listings. Nynex offers regional editions that cover the entire U.S. DDA offers a northeast edition only, and the data comes from Nynex's database, which contains 11 million listings. Both products allow searches by name, address, ZIP code, telephone number, or area code. You can limit the search within a category.

Once an entry is on-screen, you can list all entries for neighboring addresses. Both products include 800-number listings; Phonedisc also allows searches on its 800-number listings by business category. Prices for Fast Track vary by regional edition and update frequency. The New York/New England edition, with monthly updates, sells for $9500 per year. The Phonedisc yearly subscription is also $9500 and includes monthly updates.

DDA sells the more limited two-volume Phonedisc USA CD-ROM set for $1850. This edition includes 90 million residential listings, allows name searches only, and includes semiannual updates. DDA's QuickRef+ ($99) offers a few hundred thousand listings of "frequently called" business and government agencies. It allows searches by address, phone, ZIP code, and business classification. It does not include updates.

American Business Information (P.O. Box 27347, Omaha, NE 68127, (402) 593-4565) offers two products. Business Lists-On-Disc supports searches by business category, as well as names and addresses. You can filter searches by sales volume, number of employees, and other criteria. You can perform secondary searches, and a PC database lets you associate your personal contacts with each company.

The $5000 annual license fee includes 20,000 lookups. Business Lists-On-Disc is updated annually. A more limited version, The American Business Phone Book, sells for $198 and includes 5000 lookups. It allows searches by company name or phone number, but it includes no business category index and no updates. Both products require attaching a "dongle" copy-protection key to your parallel port.

If you require the most up-to-date, comprehensive listings for looking up residential telephone numbers or verifying addresses, Fast Track Digital Directory or Phonedisc will do the job. The added features of Business Lists-On-Disc make it the more powerful tool for business market research.

—Stanford Diehl

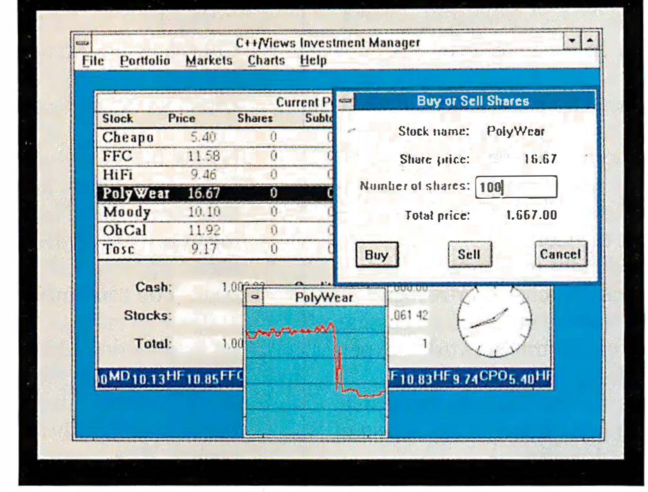
Easier to work in than a lemon yellow leisure suit.

All too often, writing a GUI application means dealing with complex and unwieldy GUI APIs like MS Windows, PM, or X/Motif.

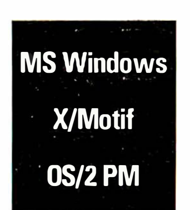
Which is the equivalent of trying to dress fashionably from a closet filled with nothing but leisure suits and white belts.

Fortunately, there's C++/Views™, the leading C++ class library for quickly developing sleek, platform-independent GUI applications.

C++/Views completely shields you from the ugliness of the underlying GUI environment and API — slashing development time on GUI programming up to 75%.



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All the GUI classes you need are provided: windows, menus, bitmaps, dialog boxes, pushbuttons, graphics, as well as classes for persistent storage, collections, dynamic arrays, and much more.

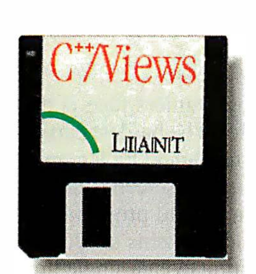
C++/Views also provides an easy-to-learn, and consistent interface to MS Windows, PM, X/Motif, and others.

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C++/Views comes with C++/Browse™, a powerful source code browser that simplifies C++ development, making it a tremendous learning tool for novice C++ programmers.

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Now $149 for MS Windows version if you currently own any other UI or GUI tool. One per customer. Call for similar special offers on other platforms.

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Extra $10 off for a photo/fax of you in a leisure suit.

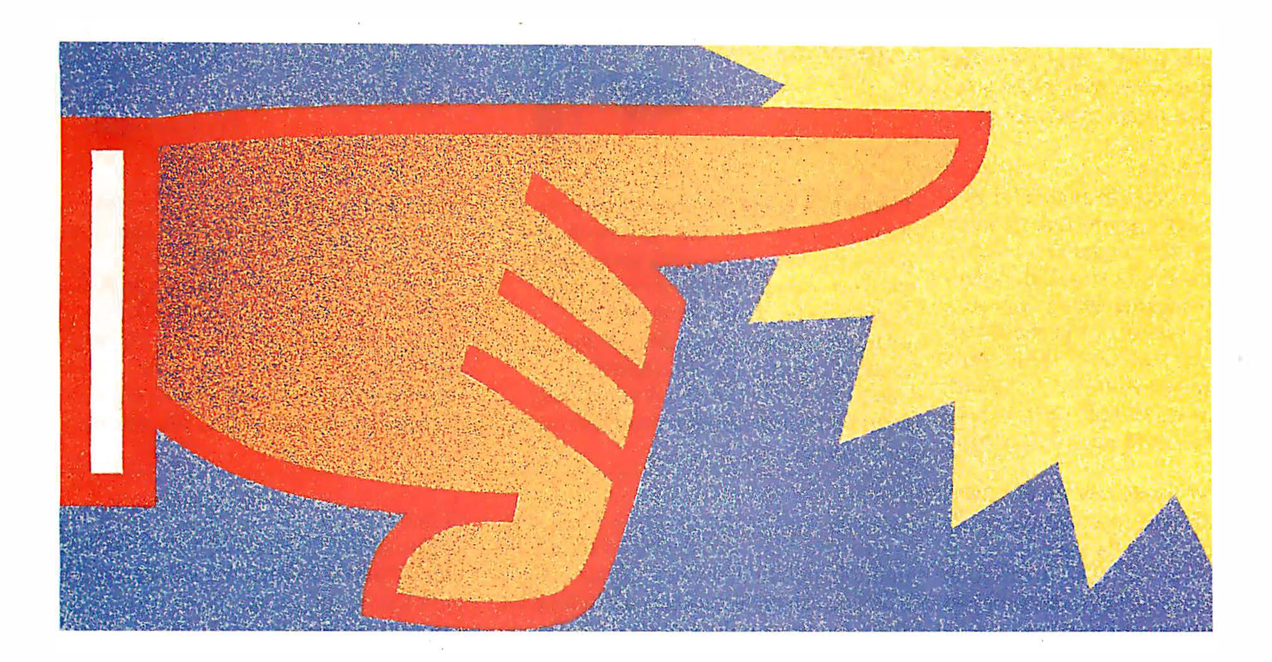
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HOWARD EGLOWSTEIN

KEYBOARDS WITHOUT KEYS



Touchscreen displays are moving beyond airport kiosks. Here's how they work.

People have been touching computer screens for a lot longer than you might think. In 1978, when I worked at MIT's Architecture Machine Group, we used an early version of Elographics' resistive touchscreen sensor to control an interactive videodisc system. It wasn't long before touchscreens began sprouting up everywhere. Anyone attending a Comdex show in Las Vegas in recent years has walked through a hotel lobby full of video gaming machines wherein computerized dealers shuffle endless poker hands onto video screens and players toss away their unwanted cards by sweeping them off the screen with their fingertips. The touchscreen is the perfect interface for these casino machines; it requires almost no maintenance, and it lets the player move quickly from hand to hand. Faster play means more profit for the casino.

Closer to home, chains of huge supermarkets are taking root in just about every corner of the U.S. and Canada. Some of these stores are literally the size of a football field. While it's wonderful to have that kind of variety at your fingertips, trying to find the Jolt cola among thousands of other items is like trying to find a bug in a 2000-page assembly language listing. These stores often have interactive video maps that help keep you from getting lost. You simply walk up to one and touch the first letter of the item you're looking for (or a picture of it). After you choose the specific item, a colorful map pops up, showing you where you are, where the item is, and the shortest route for getting to the item.

Touchscreen Parts

Aside from helping you navigate through stores and draining your Comdex travel and entertainment account, will touchscreen technology ever find its way to your desk? In a word, yes. MicroTouch Systems, Elographics, Carroll Touch, and other manufacturers want you to throw away your mouse and use a touchscreen for daily computing. It makes sense if you think about it—moving objects around with your fingertips comes naturally.

Touchscreen systems have three major components: a controller card that manages the analog sensor and converts your touch into digital information, driver software that makes this data available to your application, and the sensor, which can use one of several technologies.

Sensors usually consist of transparent pieces of glass with many special layers and treatments. The exception is the infrared screen, wherein the inside of the monitor bezel is lined with LEDs and sensors to calculate where your finger is touching the screen. Each competing technology has distinct advantages and disadvantages that determine its application.

The Unseen Controller

The hardware controller is the least visible of the three components. The front end is a collection of analog

ILLUSTRATION: MARK FISHER © 1992

hardware—usually A/D converters, voltage multiplexers, and other basic data acquisition hardware that sends voltages to the screen sensor and reads back the results. The back end is a digital interface (bus, parallel, or serial) containing the touch data. A microprocessor holds the two ends together and does the magic.

Actual implementations vary with the technology used, but all controllers look and act the same from the system's point of view. You connect the sensor to one end and your computer to the other. From the computer's end, a touch looks like a series of *x* and *y* (and sometimes *z*, for pressure) coordinate groups.

Controllers can take several physical forms. Internal cards are available for PCs and other computer systems that fit within the computer or the computer monitor's housing. This design is small, inexpensive, and easy to integrate into a final configuration. Most vendors offer their controllers in an external case; these units usually communicate with your computer via the RS-232 port. Though more expensive, they offer a bit more configuration flexibility.

In its simplest form, raw touchscreen data is simply a map of *x,y* coordinate pairs over time. By the time the data makes it through the software drivers, it can look like mouse movements, keystrokes, or just about any other form of input your application may need.

Moving Data

Getting data from the controller is one thing, but you also must get it into your application. Controllers return the data in some defined protocol. Each manufacturer has its own data format, and each controller has different resolutions and command sets. Mice and graphics tablets have a few de facto standards; unfortunately, touchscreen manufacturers haven't got together yet. The market, while growing fast, simply isn't big enough to establish a clear leader.

At one level, the manufacturers provide a low-level interface, usually through a software interrupt or device driver. To talk to this interface, your application must interpret the incoming data in raw, unscaled form. That's not a problem when you consider that the data is made up of linear points from the minimum to maximum values. To map these to your screen, you just divide the number of addressable points on the touchscreen by the number of points on your display system.

Manufacturers are now looking at selling touchscreens for Mac and Windows setups. The Mac controllers/software drivers look just like any other pointing device and work transparently with all software. The Mac was designed to handle multiple pointing devices at once. If you like, you can run a trackball, a touchscreen, and a mouse simultaneously.

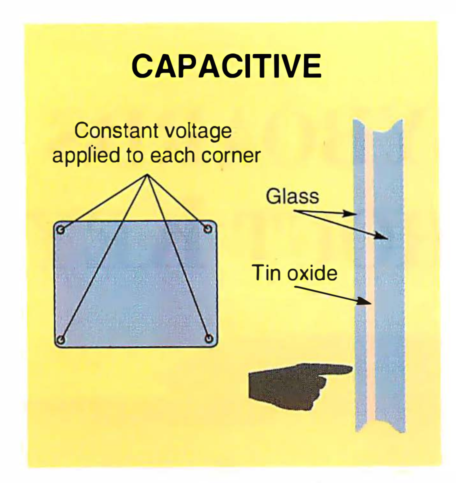


Figure 1: *A capacitive sensor uses the human finger as a capacitive probe to draw a minute amount of current from the four screen corners. Each corner supplies a level of current that's proportional to its proximity to the point of contact. The controller determines the probe's* x,y *coordinate position by measuring the current at each corner.*

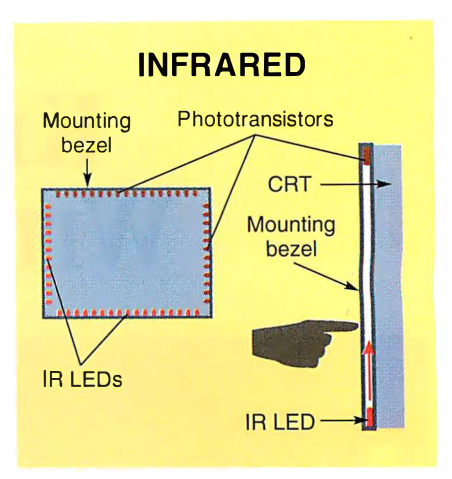


Figure 2: *Infrared systems use arrays of LEDs and phototransistors. You don't have to touch the screen to activate it; merely breaking the path between one of the infrared LEDs and its corresponding phototransistor registers a touch and reports the position. Infrared touchscreens often use strain gauges to detect the actual touch.*

Microsoft didn't allow for multiple pointing devices when it created Windows, so getting multiple device support for Windows is trickier. MicroTouch Systems (55 Jonspin Rd., Wilmington, MA 01887, (508) 694-9900, fax (508) 694-9980) solves the problem by providing its own Windows driver that supports both its touchscreen and a Microsoft-compatible mouse. Elographics (105 Randolph Rd., Oak Ridge, TN 37830, (615) 482-4100, fax (605) 482-4943) has a more elegant solution: Its Windows driver supports the touchscreen directly and looks for an existing INT 33h mouse driver (e.g., Mouse Systems' MSCMOUSE or Microsoft's MOUSE.COM). If it finds one, it incorporates the mouse data into its own data stream. Any DOS pointing device, regardless of whether it has Windows drivers, will then work from within Windows.

The Capacitive Sensor

Manufacturers generally use one of five sensor technologies: capacitive, infrared, resistive, surface acoustic wave, and strain gauge. Capacitive touchscreen sensors rely on the fact that the human body acts as a capacitor when it is in the presence of an electrical charge, and it stores up some of that charge.

The sensor consists of a layer of glass that's curved to match the shape of the monitor. A thin, transparent layer of tin oxide coats the entire glass surface. A protective glass layer goes over the tin oxide to form a hard, durable outer coating (see figure 1).

To read back touchpoints, the controller puts a low AC voltage at each of the four screen corners, creating a constant voltage field across the sensor. A resistor grid around the screen edges ensures a constant voltage across the entire screen area. When you place a capacitive object, such as your finger, in contact with the sensor, it draws a tiny current, which comes from the four screen corner points.

If you touch the upper left corner of the screen, all the extra current comes from that corner. If you move your finger across from left to right, the upper right corner contributes a proportionally increasing amount of current until you reach the upper right corner; then that corner provides all the current. The controller's microprocessor continually monitors the current drawn from each of the four corners and determines how much of the overall current draw comes from each. The controller performs a bit of math, calculates a ratio or two, and knows the position of the sensor.

The capacitive touchscreen's exterior glass coating makes it wear-resistant, so it's ideal for public information kiosks. Activating the touchscreen requires no

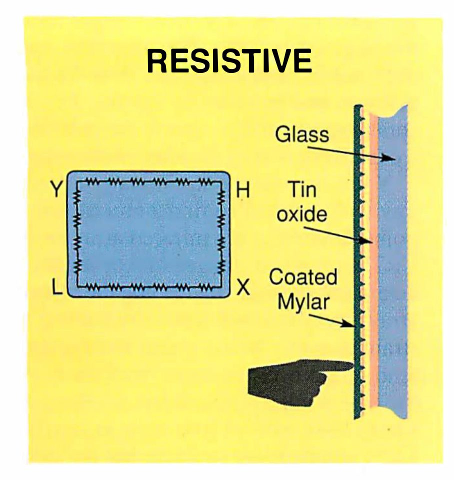


Figure 3: *Resistive screens use a Mylar covering with a conductive coating. When you press on the Mylar, it makes contact with the coated glass underneath. The conductive layer acts as a voltage probe. Here the controller applies voltage to points H and X and grounds points Y and L to measure the horizontal position. It then applies voltage to H and Y and grounds L and X to measure the vertical position.*

pressure at all. If you plan to put a touchscreen system outdoors or need to clean the screen frequently, the fact that you can seal the sensor tightly to the monitor bezel is a big benefit. One possible downside is that this type of touchscreen requires skin contact. Raindrops won't register a false touch, but on a cold day you must remove your gloves to use a capacitive system.

Infrared Beams Up

Along the edge of an infrared touchscreen, arrays of infrared LEDs squirt a series of beams across the face of the tube (see figure 2). One LED array points horizontally and has a corresponding phototransistor array directly opposite from it. Another LED and phototransistor pair runs vertically. These four arrays are mounted in a frame that sits between the monitor bezel and the CRT face. A phototransistor picks up the beam from the opposing LED.

When you place a finger or any other object in a beam's path, it blocks one or more sensors. The controller pulses each LED in turn and looks for these blocked paths. The LEDs have to be placed far enough away from the glass surface so that the CRT curvature doesn't block any of the beams in the middle. On a color screen (which usually curves more than a black-and-white screen does), that distance is noticeable; your finger breaks the beams before you actually touch the screen. As you take your finger away, the infrared sensor continues to register a "touch" until you completely clear the array.

The fact that the infrared sensor doesn't measure an actual screen touch can be a big drawback for some applications. Adding strain gauges is one solution; creative programming is another. One common trick is to wait until the coordinates stay steady for a relatively long time (about a second) before registering a touch. Infrared sensing is unique in that it doesn't require a protective glass covering over the display; this glass cuts down the display's intensity. An infrared system's screen colors stay bright and clear.

Carroll Touch (P.O. Box 1309, Round Rock, TX 78680, (512) 244-3500, fax (512) 244-7040) manufactures infrared screens for Zenith, GoldStar, and other companies. Typical applications for this kind of screen include process-control systems, multimedia applications, medical-control systems, and even fast-food point-of-sale terminals.

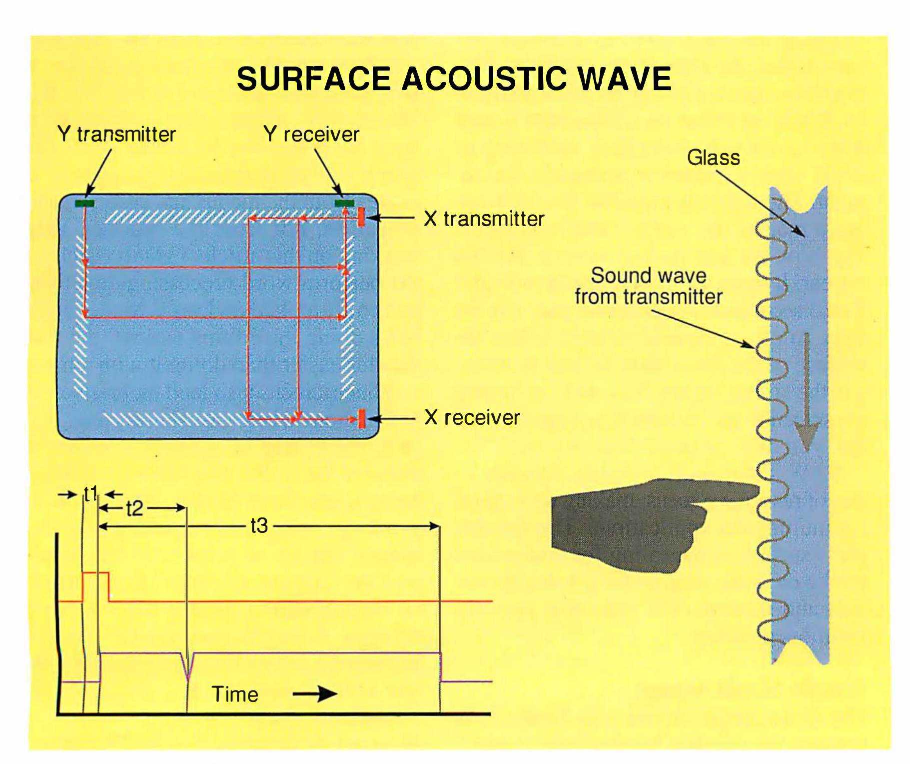


Figure 4: *SAW technology measures sound-pulse attenuation as the sound pulse travels over the surface of the glass. Part of the pulse returns quickly because it bounces off reflectors placed close to the transducers (t1). The part of the pulse that has to make the longest trip takes the longest amount of time (t3). When a solid object touches the glass surface, it absorbs part of the pulse at that point and causes a dropout in the received signal. The time between the start of the pulse and the dropout (t2) determines the position of the object.*

Resistive: Fragile, Complex

Resistive sensing is one of the oldest and most complex touchscreen technologies. It is also arguably the most fragile. It starts with a coated piece of glass, much like that of the capacitive touchscreen (see figure 3). A resistive grid surrounds the edges of the coating. To this surface, the manufacturer adds a Mylar sheet that is coated with conductive material and specially molded to have little bumps. When the Mylar is stretched over the glass, the bumps prevent the coating on the plastic surface from touching the coated glass. To keep the plastic from wearing out, a hard coating is applied to its outer layer.

The controller puts out a steady 5 volts at all four corners of the glass and reads the voltage on the conductive part of the plastic layer. If you're not touching the screen, there's nothing to read. When you press the plastic, it caves in and makes contact with the glass. The conductive layer acts as a voltage probe and picks up the voltage from the screen. The controller knows that you touched the screen, but it doesn't know where. It then puts out 5 V at two adjacent corners and brings the opposite corners down to ground. The resistive grid ensures that the glass now has a linear voltage gradient from one edge to the other. Reading the voltage from the plastic voltage probe gives the controller an accurate measure of the touchpoint. A reading of

0 V means you touched the screen at the grounded edge. A 1-V reading reflects a touch that's a fifth of the way from that edge, and so on. After measuring in one direction, the controller switches the corners and measures in the other direction.

Unlike a capacitive screen, a resistive screen doesn't care what you use to touch it; gloved fingers work just as well as bare skin. This type of screen requires a bit of pressure (3 or 4 ounces on an Elographics AccuTouch screen), and the plastic surface is more easily damaged than a capacitive glass screen. In addition, the many layers in a resistive screen block between 40 percent and 45 percent of the light coming from the CRT. For those reasons, most resistive screens are used for process-control and point-of-sale applications rather than public videotext environments.

Sound Sense

Sound waves travel at a constant speed that varies only with the medium you send them through. An SAW (sound acoustic wave) touchscreen starts with a single piece of glass with two transmitters and two receivers in each corner (see figure 4). A series of wave reflectors are cut into the glass surface—down the sides and across the top and bottom. A transmitter sends out a short 5-MHz pulse in one direction along an edge. As the pulse leaves the corner, portions of it bounce off each reflector. Those portions that are lucky enough to make the bounce early have a shorter path to travel from transmitter to receiver. The unlucky ones must travel farther down the glass and then make it across the screen and all the way back to the receiver. The transmitter sends out a short pulse; the receiver sees a much longer one—a composite made up of all the different paths that the pulse broke into as it hit the reflectors.

Touching the glass blocks the energy from reaching the receiver through that point. As a result, the receiver sees a hole chopped out of the received signal. The time between the start of the pulse and when the signal drops out determines the touch coordinate, since sound travels at a constant speed through glass (speed × time = distance). The harder you press, the deeper the hole. Not only can the controller decide how hard you press, but in theory it can look for several holes and track multiple objects at once. The current crop of SAW controllers don't do that yet, however. To measure both x and y coordinates, the controller alternates between two pairs of transmitters/receivers.

SAW technology takes longer to measure coordinates than the other sensing technologies do. The Elographics IntelliTouch SAW controller requires between 50 and 85 milliseconds per coordinate pair, versus 20 ms or less for a capacitive or resistive screen.

Using uncoated glass as a sensor surface makes the sensor very resilient; Elographics claims a life of 50 million touches. While scratches on a capacitive screen don't have much of an effect, scratching an SAW screen creates a permanent touchpoint. The controller handles this by keeping a map of the surface and remembering how an untouched screen should appear. It treats any touch that lasts longer than 3 seconds as a defect and adds it to the map. Another potential problem is that the surface of the glass must be free to transmit the sound waves. You have to mount the screen to the monitor bezel carefully so that you don't impede these waves.

SAW sensors offer clarity superior to that of resistive screens, making them good for multimedia applications. The durable glass surface is appealing for unattended public devices, such as the gaming terminals and supermarket videotext systems mentioned earlier.

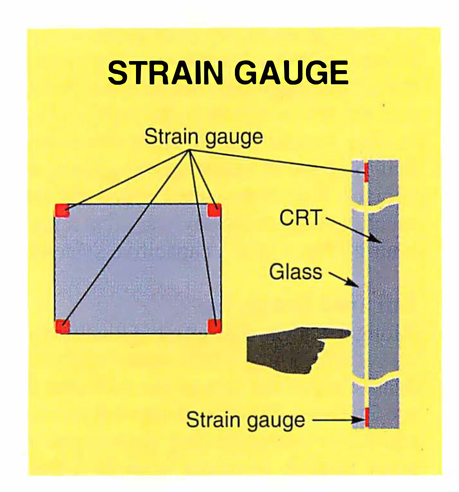


Figure 5: *A strain-gauge touchscreen uses a floating surface mounted on pressure sensors. The sensors closest to the touchpoint report a proportionally higher value than those that are farther away.*

Simple Strain Gauge

The strain-gauge sensor (see figure 5) is perhaps the simplest touchscreen technology of all. The manufacturer mounts a plain piece of glass over the CRT with a strain gauge at each corner. The strain gauge exhibits some change in electrical characteristics (most likely voltage or resistance) when you apply pressure; each of the four sensors records a change. The harder you press, the bigger the change; the sensors closest to your finger record the largest variation. The controller reads each sensor and calculates your finger's position and pressure by treating the sensors proportionally—much the same way a capacitive screen handles positioning.

You can combine strain-gauge technology with infrared to find a precise touchpoint. Mounting the infrared array on the CRT with strain gauges makes it easy to determine position (by reading the infrared array) and the actual touch (by reading the strain gauges). Strain-gauge touchscreens tend to have very coarse resolution. For the best accuracy, the object touching the screen must have as little mass as possible. Early strain-gauge systems had the entire CRT mounted on gauges; later systems had a separate piece of glass mounted over the CRT. Products using this technology include IBM's Model 8516 monitor and TouchSelect monitor add-on units, which the company claims offer up to 256 levels of sensitivity.

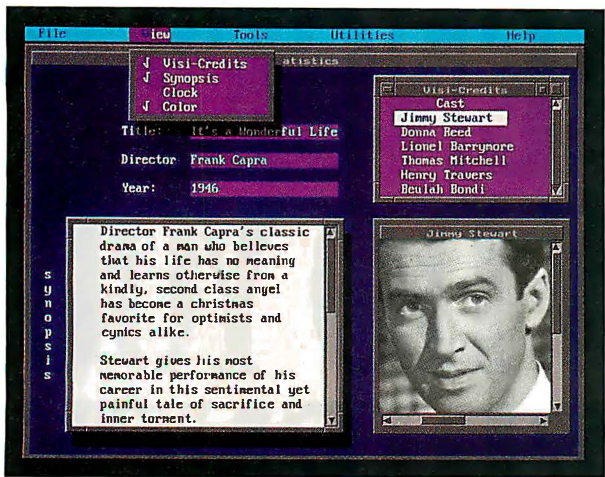
The Right Touch

I've been installing touchscreens for years in interactive video systems, in training and information kiosks, in what are now called multimedia systems, and in special-education computers. Even so, I still enjoy watching people's reactions when they encounter a touchscreen for the first time. No one gets excited over keyboards, and mice are confusing for novice users (with windowed environments, any ease of use comes from the menus and consistent presentation, not from the mouse). While working on this article, I got to watch people perform word processing on a touchscreen. It looked awkward to me, but the folks doing the editing assured me that it was far easier than doing it with a mouse.

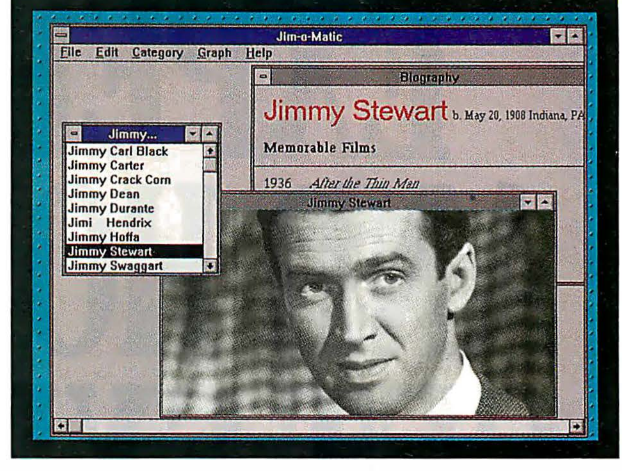
Touchscreens also lend themselves well to situations where casual users (e.g., those in airports and at automatic teller machines) have to interact with them. If there's one thing people are good at, it's pointing. When you're putting together a system that lots of people will use, or when you need to seal a system against damage or the elements, take a look at touchscreens. A touchscreen system can bring interactive computing to people in a way that nothing else can. ■

Howard Eglowstein is a BYTE Lab testing editor. He is a former vice president of Hindsight, a company specializing in handwriting and speech-training systems for learning-disabled students. He has been designing electronic toys, consumer products, and interactive computer systems for 15 years. You can reach him on BIX as "heglowstein."

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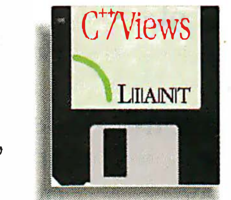
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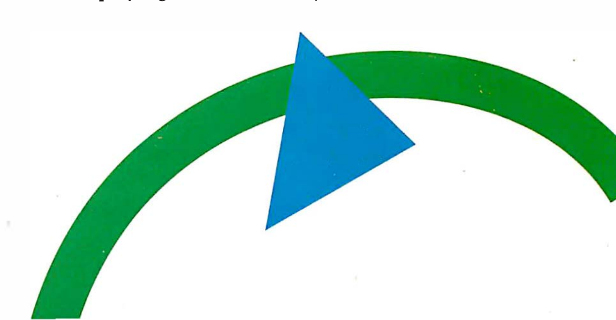
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TOM THOMPSON

MACINTOSH MENUS REVEALED



Don't gloss over this part of the Mac GUI in your programs

Think back to that last killer Macintosh application you used. It may have been a spreadsheet, a terminal emulator, a drawing package, a word processor, or even a disk utility. What made it useful to you? I would wager that most of the answers would center around ease of use. When it came to making choices about managing files or using certain features, you probably didn't think twice about how you did it. Now think of that Mac application where you kept searching around through the menus, wondering where the programmer had hidden a certain selection. Awful, wasn't it?

Well-designed and well-implemented application menus don't get in the way, so most users don't think about them. Many programmers also overlook the importance of menus in their application design. They take the menu's accomplishments for granted.

This month, I'm putting menus into the spotlight to give them the recognition they deserve. I'll cover the types of menus available to the Mac programmer, when to use them, and how to implement them. I'll also provide a few guidelines on designing menus so that they don't intrude into an application's operation: Your users will appreciate your menus by their very absence. First, however, you must know the basics.

The Mac's Three Menus

At the top of the Mac's main screen is a white zone, termed the *menu bar*, where the application's menu titles appear. Clicking on a menu title drops down a list of choices, or *items*, relevant to the operations spelled out by the menu title (see figure 1). For example, under the Finder's File menu you'll find various file management commands: New Folder, Open, Get Info, Print, and so on. This is the basic "pull-down" menu, so called because it drops down like a window shade. A battery of related Toolbox functions—the *Menu Manager*—and system code handle mouse tracking in the menu, highlighting items, and blinking an item when you select it (by releasing the mouse button).

Notice that to the right of certain menu items there's a Command-key symbol (the cloverleaf) and a character. These indicate that the menu item has a keyboard equivalent: Holding down the Command key and typing the displayed character picks the menu item just as if you had selected it with the mouse. This provides a handy shortcut for frequently used application commands.

You'll also notice that some menu items can be grayed out or dimmed. These dimmed items are disabled, meaning that they can't be selected at that time. For example, in a word processing application, the File menu's Save File and Print items would dim when you closed a document, since there's no document for these commands to act on.

The Mac even has a mechanism for handling those



Figure 1: *The Finder's File menu, a typical pull-down menu, includes keyboard shortcuts on the right and unavailable selections in gray.*

mile-long menus that are larger than the small screens found on compact Macs such as the Mac Classic. The Menu Manager literally sizes up the situation and adds scroll arrows to the menu's top and bottom so you can get at the hidden items; you just move the mouse to either end of the menu, and the item list automatically scrolls up or down.

After several years, Apple enhanced the Menu Manager by adding two new menu types: hierarchical menus and pop-up menus. Hierarchical menus typically organize related pull-down menu choices via submenus that appear alongside the designated item. The visual cue that a menu item has a submenu is a right-pointing arrow, located where the keyboard-equivalent symbols normally go. When you select the item, the submenu appears, as shown in figure 2.

Pop-up menus usually appear in dialog boxes, away from the menu bar. They act as a special control where a choice must be made among a large number of objects. A box with a title and a drop shadow represents the menu title, and clicking on this box "pops up" a menu with the item list. An example of pop-up menus is Remote Access's Setup Control Panel, shown in figure 3. Both the modem-type selection and the port choice are pop-up menus. Because the drop shadow for the pop-up title box wasn't always obvious to the user, in System 7.0, Apple added a downward-pointing arrow to the pop-up menu titles to supply an extra visual cue.

Behind the Screens

Now that you understand why menus are an essential part of an application's interface, you're probably itching to fire up that compiler and try your hand at making a few menus yourself. First, however, you'll need to know the basics of what's going on behind the screen.

The Menu Manager tracks the various menus through a set of dynamically allocated *menu records.* These records contain information such as the menu's ID number, its dimensions (in pixels), its title and item entries, and whether the menu itself or items within it are enabled or disabled.

The Menu Manager also keeps a *menu list* that contains handles to all the menus in the menu bar. This menu list changes as menus are added to or removed from the menu bar (e.g., when you switch to another application, or when you open a DA [desk accessory] that adds a menu title to the menu bar). You don't have to worry about the contents of these data structures, because the Menu Manager sets them up and maintains the information for you. As with most other fundamental Mac data structures, you shouldn't go poking around in these records and lists. There's a boatload of Menu Manager traps that let you set up and change menus without having to modify these structures.

The Mac offers two ways of building your application menus. The first way is to assemble the menus yourself, using code and the appropriate Menu Manager traps. Special *metacharacters* embedded in the item name indicate whether the item's text has a specific style, a submenu, a Command-key equivalent, or an icon associated with it. You might use this method in a self-contained code resource, such as an FKEY.

The second—and better—way to build application menus is to create the menus as resources and then use other Menu Manager traps to set them up. It's better to use resources because they isolate the menu contents from the application code. With resources, you can alter the menu contents simply by using a resource editor such as Apple's ResEdit or Mathemæsthetics' Resourcer. This way, you can translate a properly designed application into a foreign language without recompiling the application code.

Menu resources are in a special format, termed MENU, and contain the menu ID number and the text of the menu's title and item names. Keep track of those menu ID numbers: Most Menu Manager traps require them to work with the menus in the menu list. For the same reason, every menu ID must be unique.

Menu Making

You are now ready to create your own menus. First, initialize the Toolbox Managers that the Menu Manager relies on. These are QuickDraw; the Font Manager, which displays the menu titles and items; and the Window Manager, which passes the mouse-down event in the menu bar or pop-up box to your application. In the past, you had to call `InitMenus()` to initialize the Menu Manager, but today the Window Manager initialization call does this for you.

Next, you build your menus. If you're assembling them by hand, you pass `NewMenu()` an ID number and a name. This creates the handle to a menu record that uses the supplied name as its title. Then you call `AppendMenu()` as many times as necessary to add items to this menu. Finally, you call `InsertMenu()` to add the menu to the menu list.

If you use resources to construct the menus, call `GetMenu()`, passing it the IDs of the MENU resources. Or use `GetNewMBar()` to load an entire menu list at once. The last step for every case is to call `DrawMenuBar()`, which has the Mac redraw the menu bar with the new menus.

If necessary, you enable and disable the appropriate menu items with `EnableItem()` and `DisableItem()`, respectively, or checkmark items with `CheckItem()`. When you're done with a menu, you discard the handle and its memory, using `DisposeMenu()` if you used `NewMenu()` or using `ReleaseResource()` if you used `GetMenu()`.

Check for mishaps during this process—nothing is more aggravating than watching an application die horribly at launch. Listing 1 shows a code fragment that I wrote in Symantec's Think C 5.0.2. This setup module initializes the various Toolbox Managers and then loads several menus from MENU resources. It indicates some default settings by checkmarking two items. The code does some error checking: If it can't load the required MENU resource, it aborts the setup process, passes a failure condition (FALSE) to the main program, and lets the program deal with the problem.

Hierarchies and Pop-ups

Notice in listing 1 that I passed a value of 0 or –1 to `InsertMenu()` when installing the menus in the menu bar. A 0 indicates that the menu is to be added after all other menus. The –1 indicates that this menu either has a submenu or is a pop-up menu.

The Menu Manager deals with this apparent ambiguity by assuming that the menu has a submenu unless you indicate otherwise with a call to PopUpMenuSelect(). If you're still fuzzy about how this works, never fear—a closer look is in order.

I'll backtrack a bit by assembling another menu. Say I'm building a menu titled Edit, and I have a handle to it called EditMenu. I can place some items in it with the following code:

```
AppendMenu(EditMenu,'Undo/Z;
(-;Cut/X;Copy/C;Paste/V');
```

I know C code can look outré, but the second argument string is actually a mix of item text and those metacharacters I described earlier. The metacharacters aren't stored in the menu itself, but instead make the Menu Manager alter the relevant fields in the menu record. These fields control the menu item's text style, whether or not it has a checkmark symbol beside it, and describe the item's keyboard equivalent (if any). Table 1 shows the complete metacharacter list and the meaning of each.

Why bring up metacharacters? Because Apple did a clever job of retrofitting hierarchical and pop-up menus into the Menu Manager without breaking existing applications. As table 1 indicates, Apple added metacharacter support for these menu types. Apple reused the menu item's checkmark and keyboard-equivalent fields in the Mac to store the escape code and the submenu's ID. That's because an item with a submenu shouldn't be checkmarked or have a keyboard equivalent. (The submenu's items can have their own keyboard equivalents, however.)

As for the submenu itself, you build it with the corresponding ID number and items just as you would with a regular menu. Don't even bother with a menu title, though; only the menu's item list appears. To help clarify all this, I've provided the hypothetical menu shown in figure 4. Listing 2 shows the C code I used to create the hierarchical menu, and listing 3 shows this menu's equivalent Rez code, which you compile into a MENU resource using Apple's SARez application.

For a pop-up menu, you just build the menu normally. However, as with a submenu, the pop-up menu title isn't used. You should leave it empty or put the string "Unused" in it to remind you of what this menu is about when you have to go poking around inside the application with ResEdit months later.

To use the menu, your application calls PopUpMenuSelect(). However, you'll have to write some code to draw a pop-up box and its drop shadow and to display

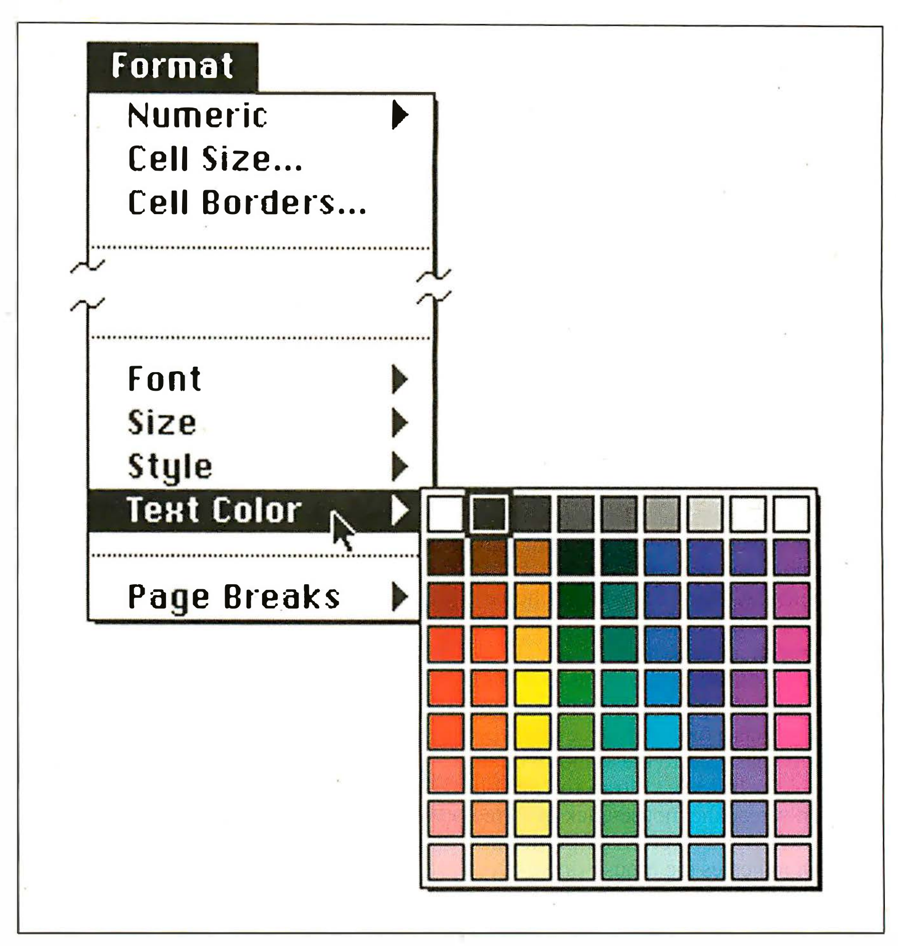


Figure 2: *A typical submenu doesn't have to present textual items. Here, a Resolve user selects a color from a submenu that's a palette.*

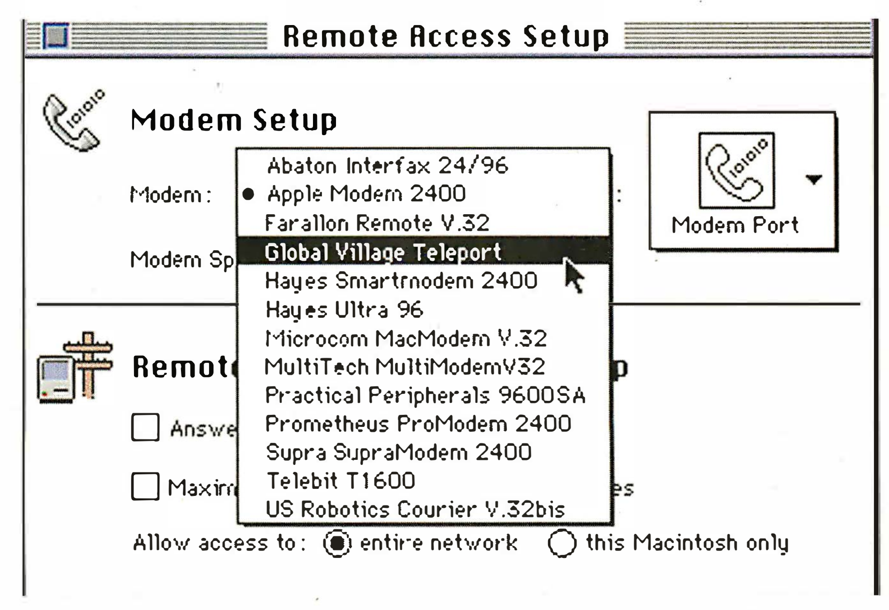


Figure 3: *Pop-up menus are one way to keep clutter out of your main pull-down menus. Here, Remote Access's Setup Control Panel pop-up menus let users select the modem type and serial port. System 7.0 adds a down arrow to menu titles to indicate that the object is a pop-up menu.*

the current menu selection. This has never been as easy as it sounds, but with System 7.0 Apple modified the `NewControl()` trap to provide pop-up menu support. You call `NewControl()` with a `procID` of 1008 (specifying a pop-up menu) and provide the menu ID in the `min` parameter. `NewControl()` then handles all the sordid details of drawing the pop-up box and managing the menu.

Retrieving Choices

After all that work you've done setting up the menus, you may think that getting the user's choices out of them is going to be another major hassle. Actually, this is the easy part, because of all the legwork you did up front. You use only three Menu Manager calls: `MenuSelect()`, which handles choices on pull-down menus and hierarchical menus; `MenuKey()`, which deals with keyboard-equivalent choices; and `PopUpMenuSelect()`, which fields pop-up menu actions.

In your application, the event-loop code circles endlessly, polling for a user event. When it detects a mouse-down event, your application passes it to the Window Manager's `FindWindow()` trap to find out where on-screen the mouse-click occurred. If `FindWindow()` returns a predefined code that indicates the mouse-down event was in the menu bar, you pass the mouse coordinates contained in the event record to `MenuSelect()`.

Now you sit back and let the Menu Manager do all the work. It pulls down the menu and tracks the mouse, highlighting each menu item as the mouse passes over it. An item's submenus are automatically pulled down as necessary.

When you release the mouse on an item, the screen is restored, and `MenuSelect()` returns a longword with two result codes inside it. The high-order word contains the menu ID, and the low-order word contains the item number. If the menu ID value is zero, no choice was made, so you return to the event loop. Note that menu item numbers start from 1 and that the menu separators (those gray or dotted lines between groups of menu items), though not used, figure in the item count.

Keyboard-equivalent menu selections start life as a key-down event. When your program gets one, it first checks to see if the user held down the Command key by examining the modifier field of the event's record. If the key was held down, the program extracts the character out of the event record's message field and passes it to `MenuSelect()`. This trap searches the menu list for the corresponding enabled menu item and returns a longword in the same format as `MenuSelect()`.

MENU METACHARACTERS AND THEIR MEANINGS

Table 1: *Apple's Menu Manager supports these metacharacters for pull-down, hierarchical, and pop-up menus.*

Metacharacter	Interpretation by Menu Manager
;	Menu-item separator in AppendMenu() trap.
(	Menu item is disabled.
-	Visible menu-item separator.
<	Item's text style, followed by a character where B = bold, U = underline, I = italic, O = outline, and S = shadow.
!	Mark indicator, where the character following this symbol marks the item.
/	Item has a keyboard equivalent whose character follows this symbol.
^	Item has an icon whose ID number follows. An icon's ID number must be between 257 and 511.
Escape	Item has a submenu whose ID number follows. The ID number must be between 0 and 255.

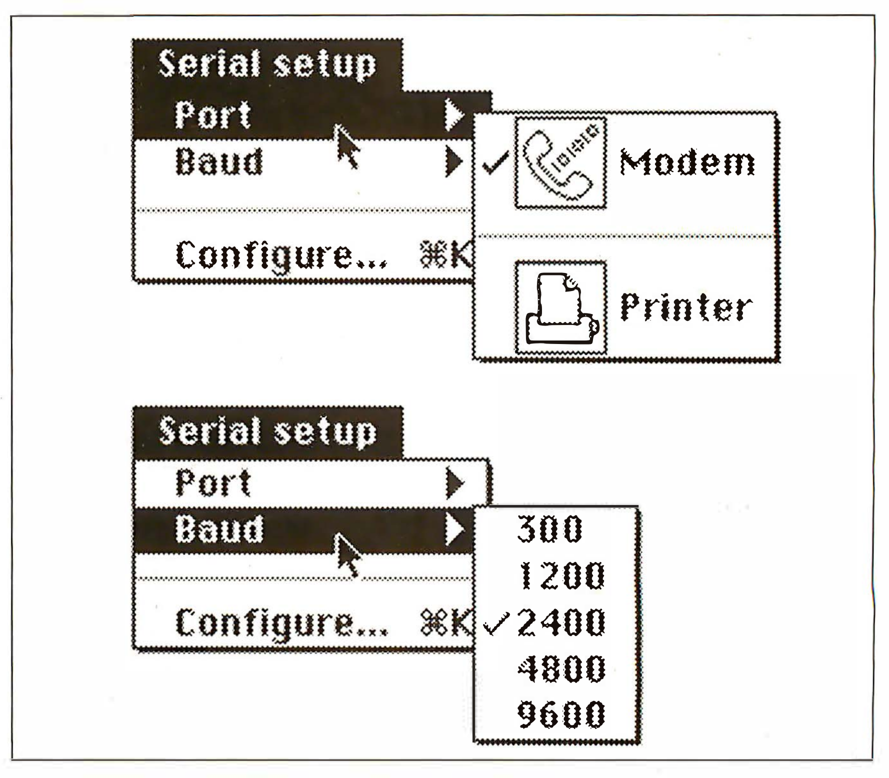


Figure 4: *A sample menu, with two submenus. Note that the first submenu uses icons. Listing 2 shows how to construct this menu with Menu Manager calls; listing 3 shows to how to build the menu using resources.*

For pop-up menus, your program should look either for a mouse-click on the pop-up box, or for when the Dialog Manager returns the pop-up box's dialog item number (not to be confused with menu item numbers) if it's part of a dialog box. No matter how your program gets the event, it passes the mouse coordinates to `PopUpMenuSelect()` and lets it handle the transaction. Finally, with the menu ID and item number in hand, you simply hop into `case` and `switch` statements to branch to the appropriate code. To further illustrate how this is done, I've created a demo application called `menu demo` that shows how to build several menus and respond to choices made with them.

Under System 7.0, you will want to

Listing 1: *Menu initialization. This code shows how to set up the Macintosh graphics environment. Note the use of error checking. The last two menus are hierarchical.*

```
/* Menu titles */
#define LAST_MENU      6   /* Number of menus */
#define APPLE_MENU     1   /* Menu ID for DA menu */
#define FILE_MENU      2   /* Menu ID for File menu */
#define EDIT_MENU      3   /* Menu ID for Edit menu */
#define SERIAL_MENU    4   /* Menu ID for Serial menu */
#define PORT_MENU      5   /* Submenu of Serial menu */
#define BAUD_MENU      6   /* Submenu of Serial menu */

/* Menu items */
#define MODEM_PORT_ITEM    1
#define PRINTER_PORT_ITEM  3
#define BAUD_2400_ITEM     3

/* Globals */
MenuHandle      myMenus[LAST_MENU+1];
short           baud;
short           currentBaudItem, oldBaudItem;
unsigned char   *serialPort;
unsigned char   MODEM[6] = "\p.AOut";  /* Modem port
                    output driver name */

Boolean Setup_Mac(void)
{
short i;

    MaxApplZone();
    MoreMasters();
    MoreMasters();
    MoreMasters();
    InitGraf(&thePort);
    InitFonts();
    FlushEvents(everyEvent, 0);
    InitWindows();
    InitMenus();              /* For old time's sake */
    TEInit();
    InitDialogs(0L);
    InitCursor();
    serialPort = MODEM;       /* Default settings */
    baud = baud2400;
    currentBaudItem = oldBaudItem = BAUD_2400_ITEM;
/* Loop and load menu resources */
    for (i = APPLE_MENU; i <= LAST_MENU; i++)
      {
      myMenus[i] = GetMenu(i);
      if (myMenus[i] == NIL)  /* Couldn't get
                                 resource */
        return FALSE;         /* Tell main() there's
                                 trouble */
      }; /* end for */
/* Load DAs or Apple Menu Items (System 7.0) */
    AddResMenu(myMenus[APPLE_MENU], 'DRVR');
    if (ResError() != noErr)  /* Problem? */
      return FALSE;           /* Mayday, we're going
                                 down. */
/* Now install our menus into the menu list */
    for (i = APPLE_MENU; i <= LAST_MENU; i++)
      if (i <= SERIAL_MENU)
        InsertMenu(myMenus[i], 0);   /* Pull-down
                                        menus */
      else
        InsertMenu(myMenus[i], -1);  /* Hierarchical
                                        menus */
    DrawMenuBar();
    CheckItem(myMenus[PORT_MENU], MODEM_PORT_ITEM,
          TRUE);  /* Checkmark modem port item */
/* Checkmark baud rate item */
    CheckItem(myMenus[BAUD_MENU], BAUD_2400_ITEM, TRUE);
return TRUE;
} /* end Setup_Mac() */
```

Listing 2: *Setting up a hierarchical menu. This is the C code I used to build the menu shown in figure 4.*

```
/* Menu data. Note the use of metacharacters. */
MenuHandle baudMenu, portMenu, serialMenu;
unsigned char SERIALLIST[38] =
{0x24,'P','o','r','t','/',0x1b,'!',5,';',
      'B','a','u','d','/',0x1b,'!',6,';',
      '(','-',';',
      'C','o','n','f','i','g','u','r','e',
          '.','.','.','/','K'};
unsigned char PORTLIST[21] =
{0x15,'M','o','d','e','m','^','1',';',
      '(','-',';',
      'P','r','i','n','t','e','r','^','2'};
unsigned char BAUDLIST[24] =
{0x18,'3','0','0',';',
      '1','2','0','0',';',
      '2','4','0','0',';',
      '4','8','0','0',';',
      '9','6','0','0'};

/* Code to create the menu in figure 4 */
   serialMenu = NewMenu(SERIAL_MENU, "\PSerial port");
   portMenu = NewMenu(PORT_MENU, "\PUnused");
   baudMenu = NewMenu(BAUD_MENU, "\PUnused");
   AppendMenu(serialMenu, SERIALLIST);
   AppendMenu(portMenu, PORTLIST);
   AppendMenu(baudMenu, BAUDLIST);
   InsertMenu(serialMenu, 0);
   InsertMenu(portMenu, -1);
   InsertMenu(baudMenu, -1);
   DrawMenuBar();
```

Listing 3: *I used this Rez code to build the menus shown in figure 4. The icon data for the modem and printer icons (icon IDs 257 and 258) is not shown.*

```
#include "Types.r"
/* The Serial menu */
resource 'MENU' (4,"Serial Setup") {
     4, textMenuProc,
     allEnabled,
     enabled, "Serial Setup",
     {
     "Port",          noIcon, "\0x1B", "\0D005", plain;
     "Baud",          noIcon, "\0x1B", "\0D006", plain;
     "-",             noIcon, noKey, noMark, plain;
     "Configure...",noIcon, "K", noMark, plain
     }
};
/* The Port submenu */
resource 'MENU' (5,"Unused",preload) {
     5, textMenuProc,
     allEnabled,
     enabled, "Unused",
     {
     "Modem",     1, noKey, noMark, plain;  /* Modem
                  icon ID (1 + 257) */
     "-",         noIcon, noKey, noMark, plain;
     "Printer",   2, noKey, noMark, plain   /* Printer
                  icon ID = 258 */
     }
};
/* The Baud submenu */
resource 'MENU' (6,"Unused",preload) {
     6, textMenuProc,
     allEnabled,
     enabled, "Unused",
     {
     "300",          noIcon, noKey, noMark, plain;
     "1200",         noIcon, noKey, noMark, plain;
     "2400",         noIcon, noKey, noMark, plain;
     "4800",         noIcon, noKey, noMark, plain;
     "9600",         noIcon, noKey, noMark, plain
     }
};
```

RESERVED KEYBOARD COMMANDS

Table 2: *Apple reserves these keyboard shortcuts for consistency across applications.*

File menu	Command	Edit menu	Command
Command-N	New	Command-Z	Undo
Command-O	Open...	Command-X	Cut
Command-W	Close	Command-C	Copy
Command-S	Save	Command-V	Paste
Command-P	Print	Command-A	Select all
Command-Q	Quit		

redesign your application so that your interface is further decoupled from the program code: The menu choice generates a high-level Apple event rather than calling the code itself. Put another way, if the user selects Print from the File menu, you create a Print Apple event instead of calling the printing code module. The reason for this indirection is to enable not only the user but also outside Apple events—coming from other System 7.0–savvy applications or from scripting languages such as UserLand's Frontier or AppleScript—to use your application.

The Art of Menus

Now that you've mastered the art of programming menus, you may think your work is done. Not so—it's only beginning. One reason menus don't get in the user's way is that the Menu Manager works so well, but the other reason is a well thought-out interface. Menu commands must make sense and be easy to remember.

Notice that I didn't mention the word *intuitive* here. Intuition is a slippery concept. What is obvious to a rocket pilot hacker-type such as myself might not be at all intuitive to the clerk down the hall. So the design of your application's menus (and the whole interface, in fact) requires careful thought. After all, it doesn't matter how good your application code is if people can't—or won't—use it because of a hostile interface.

About half the 7 million Macs out there are 68000-based machines, and with the exception of the Mac Portable and PowerBook 100, they all use those small 9-inch screens. So don't try to overload their small menu bars with too many menus. In fact, you'll want to leave some room so that a DA can sneak its menu in there as well. For the same reason, don't have "long" menus (i.e., menus with lots of items in them), even though the user can scroll through them.

If you're faced with either situation, you probably need to rethink the application's design. Hierarchical menus can help organize a lengthy menu into shorter ones, but don't get carried away: A hierarchical menu that has more than two nested submenus at a time can become a problem, especially if the user has to backtrack to the parent menu just to change one of the selections.

When you do have a menu with a googol of items or one that's spawning submenus like mad, you may want to rethink whether to use a menu for the selection process. In some instances, a dialog box with a variety of selection controls might be better suited to the job. Don't be afraid to place user choices somewhere other than in menus. In Aldus PageMaker 4.2, you can select the body text's typeface, style, color, tracking, and alignment either from several hierarchical menus or from a single dialog box. In fact, PageMaker emphasizes that users can determine how they work with the program, because they can make the same choice in two different ways.

Be consistent. One of the strengths of the GUI is that different applications act in familiar ways. For example, from the Finder, I can use Command-F (for Find) to locate a file. From MacWrite *II*, the same keystroke finds a section of text, and in the Think C compiler it finds a variable name. The Open, Save, and Print commands are the same and use the same keystrokes, too. Be aware that Apple now reserves certain keyboard equivalents as common commands (see table 2) to guarantee consistent behavior across all applications.

Finally, check out the design with real users. This gets back to that elusive "intuitive" concept that I mentioned earlier. Try out a preliminary design with many users who have different levels of computer expertise. Remember that an attitude adjustment is in order here: Don't wonder why the poor baffled user isn't getting it; rather, consider why the design isn't making the menu's function obvious.

continued

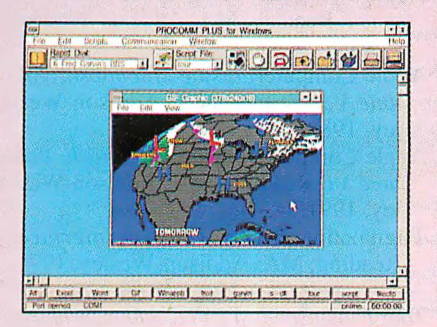
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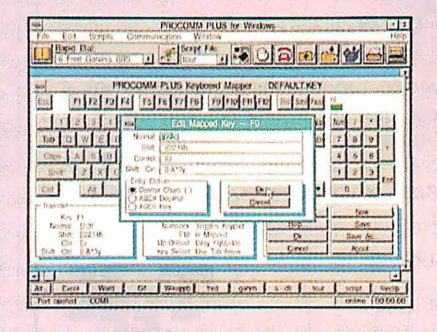
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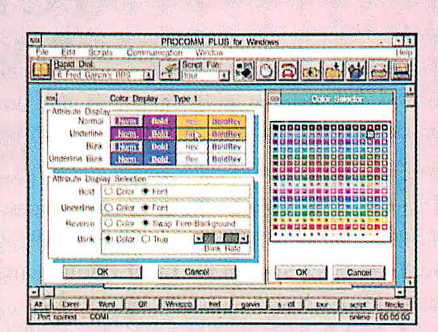
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From my own venture with Mac shareware, I've found that this can be a very humbling—and enlightening—experience. When I first released DepthKey, a utility that used only a pop-up menu, users complained about the interface. What seemed obvious or acceptable to me wasn't to a lot of MacFolk. After several iterations, I finally had an easier-to-use interface design, more features than I had thought the product could support, and satisfied users.

Two good resources that focus on interface design are Apple's own *Human Interface Guidelines* and Bruce Tognazzini's *TOG on Interface* (see the bibliography). If you take as much effort in creating an informative and useful set of menus as you do with the program code, chances are that people will use—and buy—your application.

How important are these design concepts? Look at the lessons learned in consumer electronics. Why are many VCRs difficult to program? A lot of the trouble occurs because you have to punch many buttons just the right way or you botch the programming. Just to set my VCR's time, for example, I have to hold down one button, poke at another, and then ratchet away on a third. This is easy? Some bright soul realized that rather than come up with convoluted schemes of punching buttons on the VCR's panel, you could put menus on the TV screen. You use the remote control's channel-selector buttons to move about the screen and make your choices. This setup makes sense to consumers—so much so that even nontechies now regularly tape movies with their VCRs. You can do the same for your programs if you carefully engineer the ways in which your users work with them. ■

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BARRY NANCE

Opening the Lines of Communication

A functional INT 14h replacement fills the communications gap in PC BIOS services

The communications subroutines that are in the PC's ROM BIOS don't work. The problem isn't a little bug with a small workaround; the subroutines you invoke with INT 14h just flat out aren't usable. These nonfunctional BIOS services for reading and writing characters through a COM port mean you usually have to build communications routines that write straight to the hardware.

The INT 14h services have two serious flaws: Communication is unbuffered, and they don't respond to COM-port interrupts. About all you can do with INT 14h is set a data transfer rate. The BIOS functions burned into the PC drop characters when you try to read data from a modem. When I discovered this curious omission in the BIOS a few years ago, I did what I usually do when I see software that doesn't work: I rewrote it.

INT14.COM is a TSR program that takes just under 6 KB of RAM. The program replaces the 0Bh, 0Ch, and 14h interrupt vectors as it installs itself. You can unload the TSR from memory by running it a second time with a /U command switch.

I didn't have to use a clean-room approach to avoid copyright issues as I rewrote that part of the BIOS. There was really nothing about the existing code that I wanted to reuse. I did, however, make the API look the same as the ROM BIOS code's API. You load the registers to use my functions the same way you would in calling the BIOS functions. I also enhanced INT 14h by adding additional services, and I expanded the API to include these.

INT14.COM offers service subroutines for initializing COM1 and COM2 with data-transfer-rate, parity, stop-bit, and word-length parameters. You can read and write characters to COM1 and COM2 without worrying about dropped characters. The read function will even tell you, on a character-by-character basis, if a communications error happened. Such an error might be the result of a parity error, framing error, or overrun. The read function returns a special value if the communications buffer doesn't contain any new input characters. You can ask INT14.COM to give you the current values of the Line Status Register and the Modem Status Registers.

INT14.COM does what the ROM BIOS claims to do but doesn't, and it goes a step further. When you ask INT14.COM to read an incoming character from the modem, you have two choices. You can use a function that waits for the character according to the value in RS232_TIM_OUT, a data item located at 0040h:007Ch in the BIOS data area, or you can use a function that returns immediately to your program if there are no characters in the buffer.

INT14.COM also offers functions for purging the buffer of incoming characters, returning the number of unprocessed characters in the buffer, and toggling XON/XOFF flow control. ■

MAC/Tom Thompson

Zterm Is Z-Best

You'd think that in the mature Mac applications market there would not be room for yet another telecommunications program. However, Zterm 0.9 makes room for itself by offering a boatload of high-powered features for a modest shareware fee of just $30.

David Alverson's Zterm offers screen capture and VT100 emulation. It supports XMODEM, YMODEM, YMODEM-G, and ZMODEM file transfer protocols. Zterm's built-in 10-verb scripting language lets you build scripts that automatically sign you onto an on-line service, examine mail or messages, capture them to a file, sign off, and hang up the line. You can select an on-line service from Zterm's Dial menu, and Zterm will automatically find and execute a script file of the same name.

For on-the-go MacFolk whose PowerBooks have only a small hard drive and a minimum of RAM, Zterm's svelte size (197 KB) and sparing use of memory (450 KB) make it an ideal traveling companion.

UNIX/Ben Smith

ZMODEM Meets Unix

Here's the problem: You're using a Mac or a DOS machine connected to a Unix host by a serial line or modem. You want to move some files (not necessarily text) between the two machines, so you need a protocol-based file transfer utility. What about ZMODEM?

Chuck Forsberg's `rz` and `sz` are file transfer utilities for Unix that support ZMODEM. You don't need to be a system administrator; you can compile and install this software in your own file area. The source code is only 176 KB—one of the smallest Unix programs I've discussed in Software Corner.

There is a catch: This is shareware, not freeware, so send in your $20 and get support from Omen Technology of Portland, Oregon. (The source code is available in "unix/listings" on BIX.) Forsberg is also the author of the YMODEM and ZMODEM protocols and some communications programs, including Professional-YAM (a Unix communications program for calling out to non-Unix systems).

Editor's note: *Software Corner highlights public domain, freeware, and shareware programs. The programs are available in electronic format. See "Program Listings" on page 5 for details. We solicit your contributions. We pay $50 for any program we use. Write to: Software Corner, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458.*

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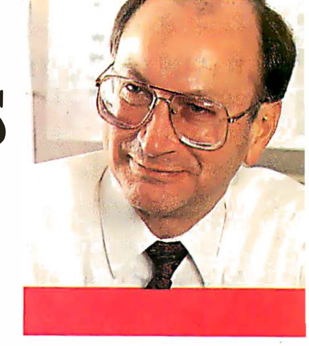
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JOHN BARKER

Writing a Device Interface for Windows

Microsoft's Windows environment has established new ground rules for PC software. Windows imposes unique challenges for device-interfacing software in particular: Interrupt handling, memory access, intermodule (software) communications, and modularity mechanisms are all different in the Windows environment. In addition, addressing approaches need careful attention to protect Windows code investment as new Windows versions become available.

What Hath Windows Wrought?

While writing device-specific software under Windows presents challenges different from those presented by DOS, Windows offers unprecedented dynamic modularity and coding consistency. Thus, while the Windows environment introduces challenges for developers, it also employs and enforces coding and usage standards that lead to the creation of code that is highly reusable.

Recognizing that true reusability and sensible object-oriented support are important to Windows success, Microsoft established conventions to help developers take maximum advantage of Windows' capabilities. However, complying with those conventions imposes a burden on software developers who wish to use this new software environment to accomplish actions that are not completely envisioned in early Windows versions (e.g., for controlling and interacting with plug-in, real-time devices).

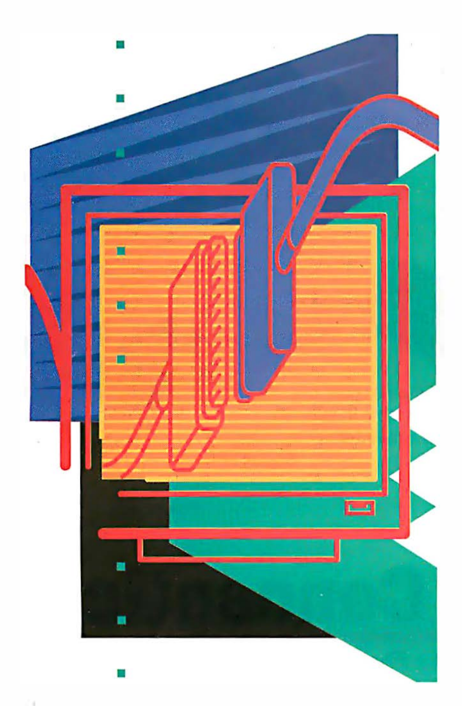
Under DOS, the programmer has almost complete control over interactions with any type of standard or nonstandard device. Interrupt service, data-space allocation, and communications between tightly coupled code segments (e.g., applications, libraries, drivers, and TSR routines) are all specified by the developer. DOS participates little in managing and controlling those aspects of device interaction.

Windows, on the other hand, wants to cooperate with, if not directly control, the handling and management of interrupts, data locations, and dynamic linking of code segments that may or may not be tightly coupled. Where the DOS programmer established all the external interaction rules, the Windows programmer must follow the Windows rules to accomplish the same functions.

No longer can a device be considered just a functional add-on; the prudent developer must carefully consider how to involve Windows in effecting specific device actions.

Windows must be made aware of interactions that once were the sole province of the device-specific application. Part of the challenge in using such devices lies in effectively employing operating modes that are alien to (or at least outside) the Windows worldview. In fact, you could turn the analogy around and discuss the challenge of accessing physical device capabilities that are not recognized by Windows' model of a device. In essence, Windows is blind to those capabilities, and the burden falls on the programmer to access Windows-unknown features using Windows constructs.

Windows poses unique challenges when writing device drivers



Allow Me to Interrupt

The Windows interrupt structure places the mouse, keyboard, and display at the top of the interrupt-service queue. Thus, using the mouse or pressing a key rips the PC's attention away from another peripheral device, even though that device may be interacting with the PC on a critical, real-time task that should not be easily or frequently interrupted.

This interrupt hierarchy makes sense when the objective is to respond quickly to operator directives issued by mouse or keyboard actions. However, it places severe demands on the real-time programmer who is attempting to move data rapidly and reliably between the peripheral device and the PC. Similarly, Windows' handling of such interrupts is modeled on the simpler devices that are normally connected to a PC.

With the potential for multiple interrupts and multiple levels of interrupts, plug-in devices introduce the need for creative real-time servicing in the Windows environment. Because Windows wants to participate in the handling of such interrupts, there is a built-in overhead that cannot be easily circumvented (if you were to attempt it at all).

The inescapable conclusion is that reliably handling real-time input and output streams requires a Windows-sensitive peripheral. This means that the peripheral must be designed to work with relatively long interrupt-service latencies. Thus, the Windows operating-environment interrupt-

ILLUSTRATION: BILL FRAMPTON © 1992

service approach has direct and significant impact on peripheral-device architecture and hardware.

Thanks for the Memory

Another difference between DOS and Windows is in memory handling. In its more elaborate addressing modes of operation, Windows prevents its applications from knowing the specific memory locations being used. It does this to facilitate virtual memory management and to allow applications to share host memory. While this is desirable from a PC management viewpoint, it introduces a serious problem: How does an application tell the external device where to bring in its data?

There are no universal answers to the old hidden-memory trick, but at Data Translation we have found protocols that work. Such conventions as centralized request and grant of memory, coupled with appropriate memory lockdowns, go a long way toward helping applications work with devices that know only to get their data from specific memory locations in the PC. However, this is not the entire answer, because the most demanding peripherals virtually mandate asynchronous memory handling.

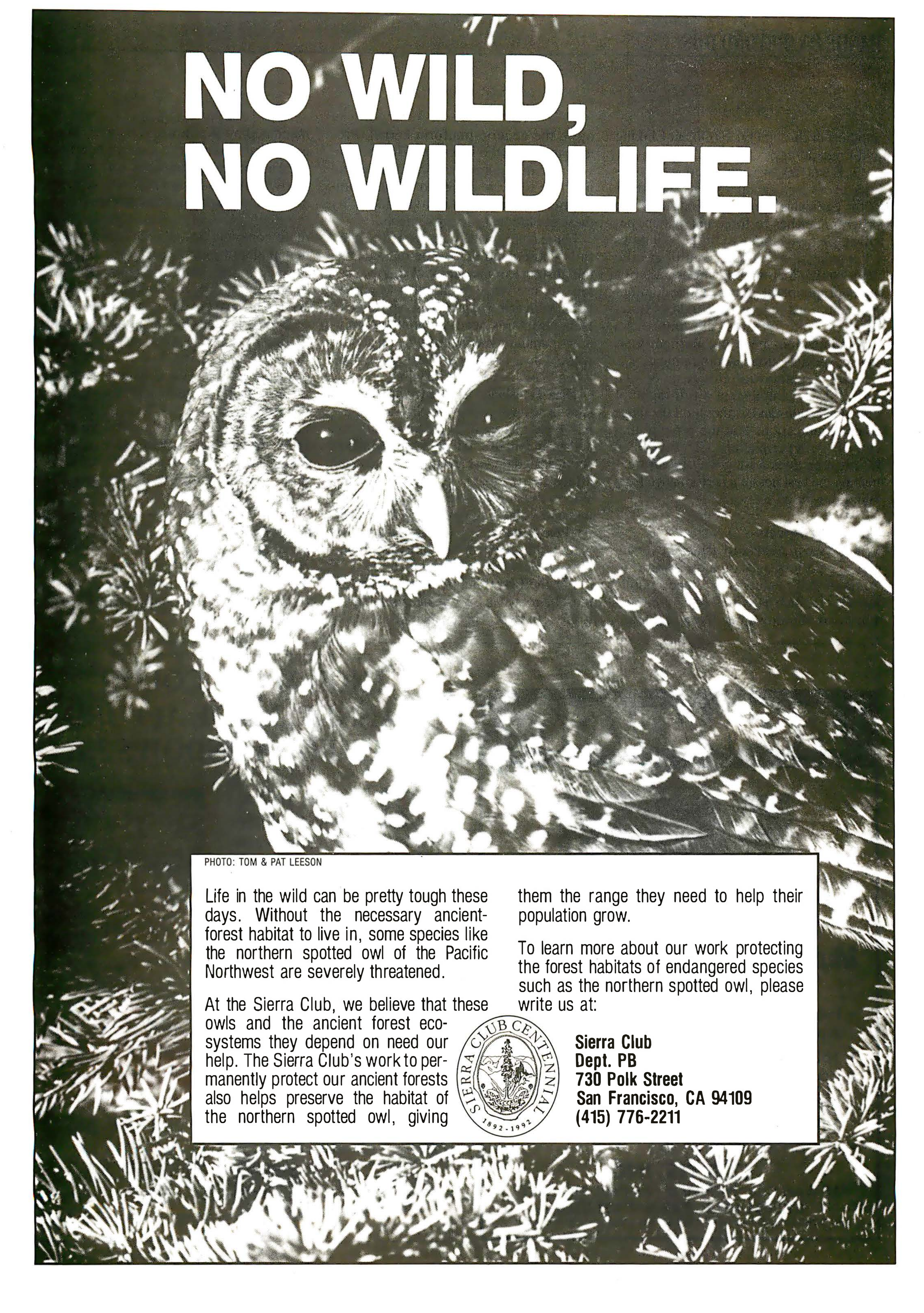
Add that mode of operation to Windows' inherent memory hiding, and the problem becomes even more difficult. Now, both the application and the host-resident device-specific software must know how to handle the filling and emptying of memory locations. These locations alternate between available and non-available as Windows manipulates and coordinates memory requests to maximize use of limited internal memory.

Another difference between DOS and Windows is in memory handling.

Is Anybody Listening?

Another difference between DOS and Windows lies in intermodule communications. Here, the Windows environment offers both constraints and flexibility. Several mechanisms are available for different purposes, including synchronous, asynchronous, and interapplication communications. Depending on the type of external device and the service being requested, each mechanism is useful.

Synchronous communications serve well for immediate commands (e.g., configuring a peripheral or preparing for a subsequent real-time activity). Asynchronous communications facilitate parallel activities (e.g., processing acquired data while simultaneously acquiring more data). Asynchronous communications are implemented via semaphores and signals, and they use Windows' ability to post messages to a receiving window (a Windows activity). Interapplication communications can occur in two ways: through DDE (which is a one-way-at-a-time mechanism for sending data from one application to


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NO WILDLIFE.
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another) or through OLE (Object Linking and Embedding).

OLE enables two applications to cooperate in one application session. Regardless of the particular communications used, the programmer has to force his or her specific communications to fit the Windows communications model. Even if specific device-related communications are critical to proper performance, those communications must fit into the Windows structure. In some settings, this imposes a communications-handling ambiguity or, worse, special-purpose communications.

Some development aids (e.g., Visual Basic) do not implement a full range of communications and further limit the range of communications that the programmer can use with peripherals. Careful design in this area goes a long way toward extracting the best possible performance from Windows-based software.

Future Prospects

Windows will evolve to achieve ever-increasing performance on more platforms. Some of that evolution is already public knowledge, such as Win32 (the 32-bit version) and Windows NT (New Technology), the generic-platform kernel. Protecting those who invest in Windows development requires foresight and careful interface software design so that those implementations aren't invalidated by these evolutionary improvements.

For example, data types need to be carefully chosen and used. You must decide the absolute minimum of Windows services to use while hoping that Microsoft will continue to support those you choose. Data structures need to anticipate Windows evolutions so that software that once worked on a 16-bit machine doesn't break when Windows moves to 32 bits.

Data Translation is dealing with these issues in several ways. We choose and use data types that are invariant under different addressing modes. We use basic Windows services and do so carefully to avoid side effects detrimental to software reliability. We establish data structures that are immune to addressing modes and word sizes. And we characterize generic external devices with sufficient flexibility to encompass a wide range of future features.

For the first time, peripheral software must be robust and facile in a user-friendly environment. This change in approach, mandated by Windows, is painful. Many issues that never were a concern now need to be addressed comprehensively and correctly. Software design now encompasses much more than just implementing timing diagrams and control structures. A more complete design that includes data management must be defined, and you must do so well before any coding occurs to ensure that the resulting code will be both interoperable and reusable.

Windows holds out the promise of true modularity if your programs use it carefully and with an eye to the future. Windows also presents the specter of complex software that's too unreliable and too slow to meet even primitive throughput standards. Those who learn the differences between developing for DOS and developing for Windows and take advantage of Windows benefits will reap the promise and avoid that specter. ■

John Barker is vice president of engineering at Data Translation, Inc., in Marlborough, Massachusetts, a manufacturer of PC data acquisition and image-processing boards. You can reach him on BIX c/o "editors."

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Migrating Backups

I'm getting an almost-new 386SX computer with either DOS 4.01 or 5.0 and an 80-MB hard drive. My present system is a 286 with a 287 math coprocessor, a 40-MB hard drive, 1.2-MB and 360-KB floppy drives, and two COM ports. Because I use DOS 3.3, I had to split the hard disk into two partitions: C is 32 MB, and D is 8 MB.

Both C and D contain programs and data that I want to transfer to the new computer. I back up my hard disk at regular intervals; I always have two sets of complete backup disks. My questions are: Does DOS 4.01 or 5.0 recognize DOS 3.3 backup disks? Will there be a problem using the old drive D backup disks to restore files to the new C drive? The C drive is partitioned as one large 80-MB drive. I have Traveling Software's LapLink III and LapLink Pro.

Any suggestions would be highly appreciated.

Hanspeter Nafzger
Kloten, Switzerland

As a practical consideration, you should opt for DOS 5.0 for your new system. It has better memory management features than previous versions. Also, DOS 5.0 will recognize the backup disks created using DOS 3.3 and restore the data from them.

I recommend you use LapLink first to transfer all your files to the 386SX-based computer. You can simply direct LapLink to copy whole subdirectories to any drive regardless of how it's partitioned. Then, after you are certain that the 386SX is running well and your files are intact, you can back up the new C hard drive to floppy disks. Doing the backup from the new computer will be faster, and your 286 will still be available as the ultimate backup.

—Stan Wszola

Windows à la Mode

I have a Novex 33-MHz 386 with 4 MB of RAM, a 125-MB IDE hard drive, an ATI VGAWonder XL card with 512 KB of VRAM (video RAM), and an Aamazing 1024-by 768-pixel monitor. The computer uses the 386CD4 motherboard with an AMD 386 and the CS2310 Peak DM chip set.

I am using DR DOS 6.0 and have configured the EMM386 memory manager to put most of everything in upper memory. This includes drivers for a bus mouse, a scanner, the Digital Research cache program, and SuperStor for the D partition on the hard disk. This leaves me with almost 618 KB of base RAM for DOS programs. It also means, however, that I can use Windows 3.0 only in enhanced mode.

Why should I need any other mode? Am I correct in assuming that standard mode is mostly for using certain DOS programs from inside Windows? The programs I use the most are Ami Pro 2.0 and CorelDraw, although I also use XTree Gold and AutoSketch with Windows. Quattro Pro, however, causes a conflict.

Roger Lavis
Lachute, Quebec, Canada

You can happily run all your Windows- and DOS-based programs in enhanced mode without ever needing to switch to standard mode. Enhanced mode gives you the maximum available resources of Windows. Running in standard mode will give you slightly better performance, at the cost of disabling multitasking and preventing the use of SWAPFILE for temporary storage.

You can't run in standard mode with your current configuration because you are using EMM386. Only Quarterdeck's QEMM-386 will let you run Windows in standard mode. If you want to run in standard mode, you must edit your CONFIG.SYS file and delete or disable the statement in the line for your EMS driver. Then reboot and run Windows with the command WIN /S.

Your problem with Quattro Pro is because its PIF (program information file) is not properly configured. Fire up the PIF editor and check the amount of memory available to the Quattro program. Quattro Pro requires a minimum of 512 KB and is much happier with more. It is designed to run on any PC (e.g., 8088, 286, and 386) and makes the maximum use of base system memory. You'll have to experiment to find the best memory setting. Also check what mode you're running Quattro Pro in (either text or graphics) and set the correct mode in the Quattro PIF.

—Stan Wszola

Where's the Unix

I am trying to locate a copy of the Unix clone Coherent from Mark Williams Co. This product was discussed by David Fiedler in "Not Quite Unix" in the November 1990 BYTE. I cannot seem to contact the distributor in England. Can you give me the company information?

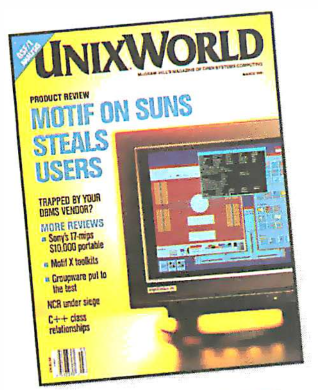
David Wilson
Norfolk, U.K.

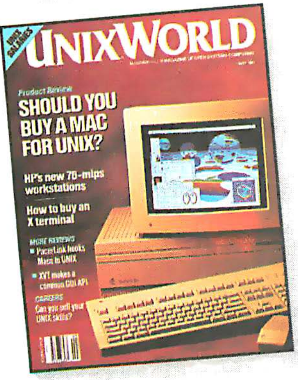
Coherent is now available in two versions: one for 286-based computers and a recently announced version for 386-based machines. Although you won't find TCP/IP networking or the X Window System bundled with these versions, you will find full multitasking and most of the Unix utilities, including UUCP and E-mail. This isn't bad for a cost of around US$100. The 286 version is limited to very small programs (small-memory model), but the 386 version uses the standard Unix flat-memory model. The C compiler is excellent.

Contact Mark Williams Co. at 60 Revere Dr., Northbrook, IL 60062, (800) 627-5967 or (708) 291-6700. In the U.K., the number to call is 91-427-6430.—Ben Smith

The BYTE Lab welcomes your questions. Address correspondence to Ask BYTE, BYTE, One Phoenix Mill Lane, Peterborough, NH 03458. You can also send BIX mail c/o "editors."

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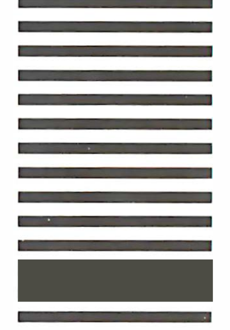
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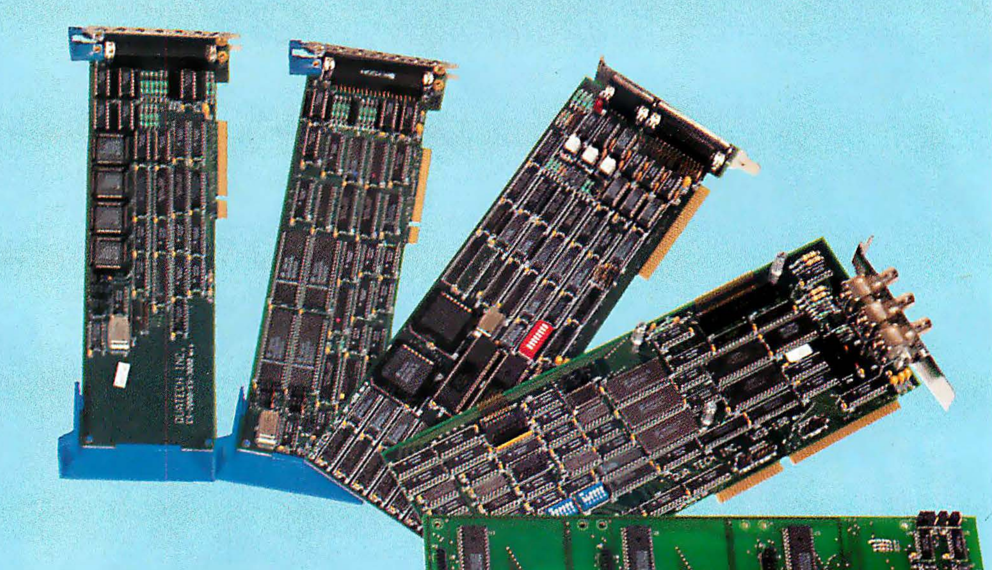
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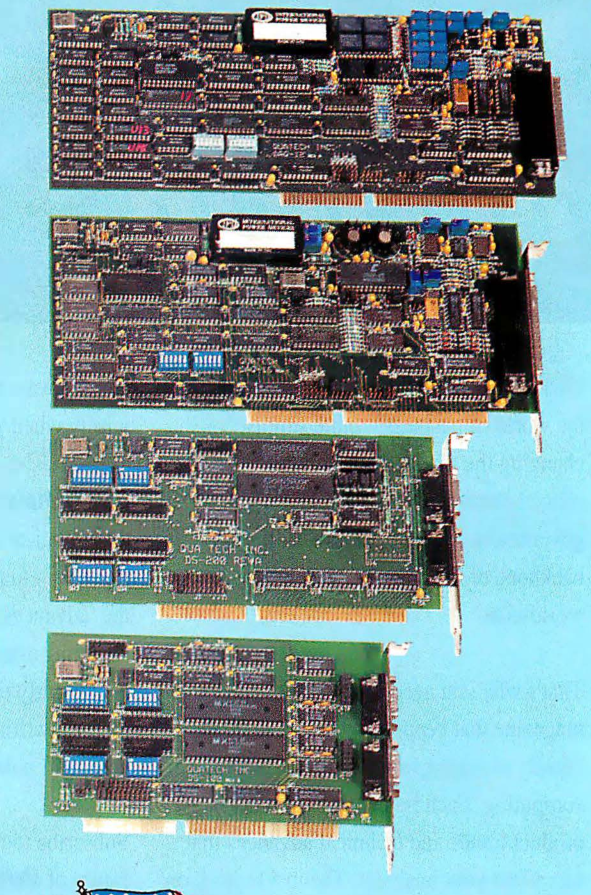
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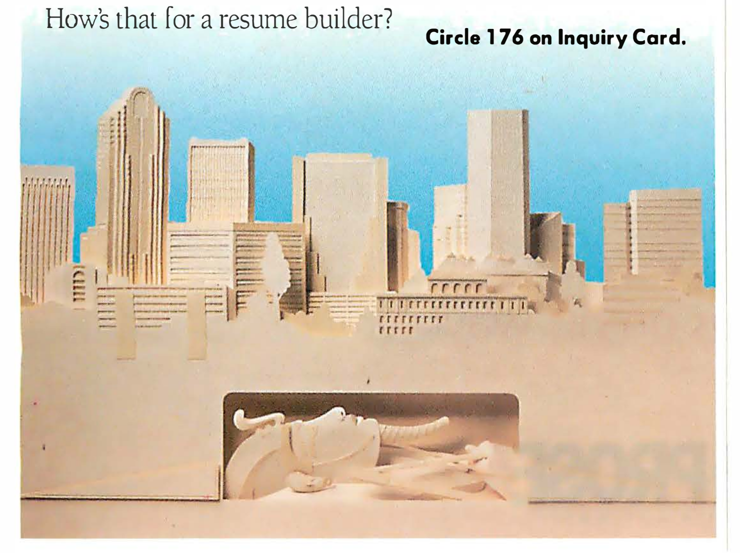
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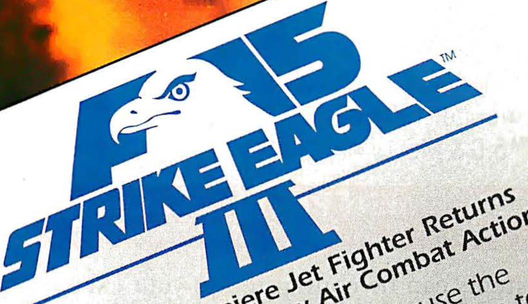


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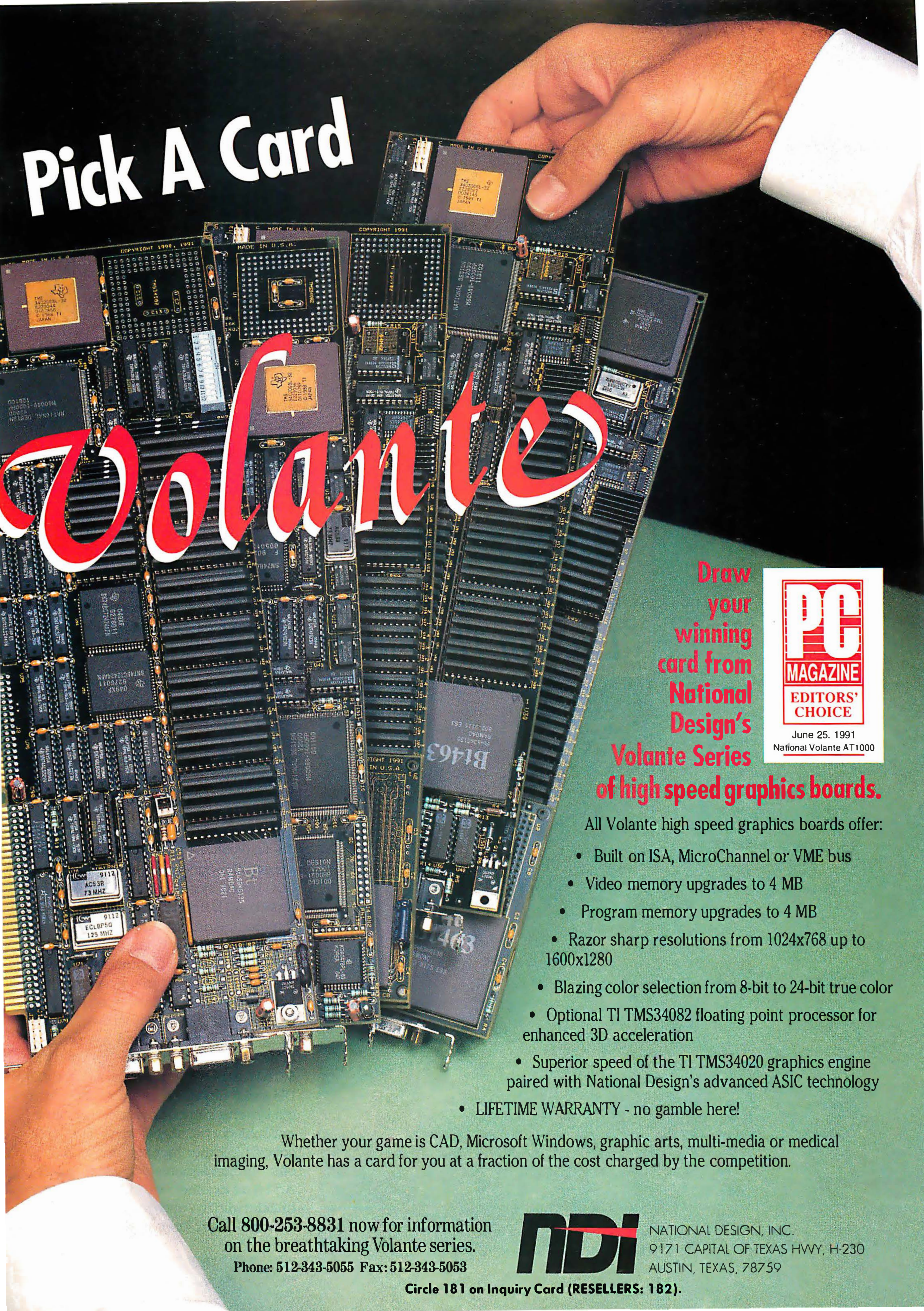
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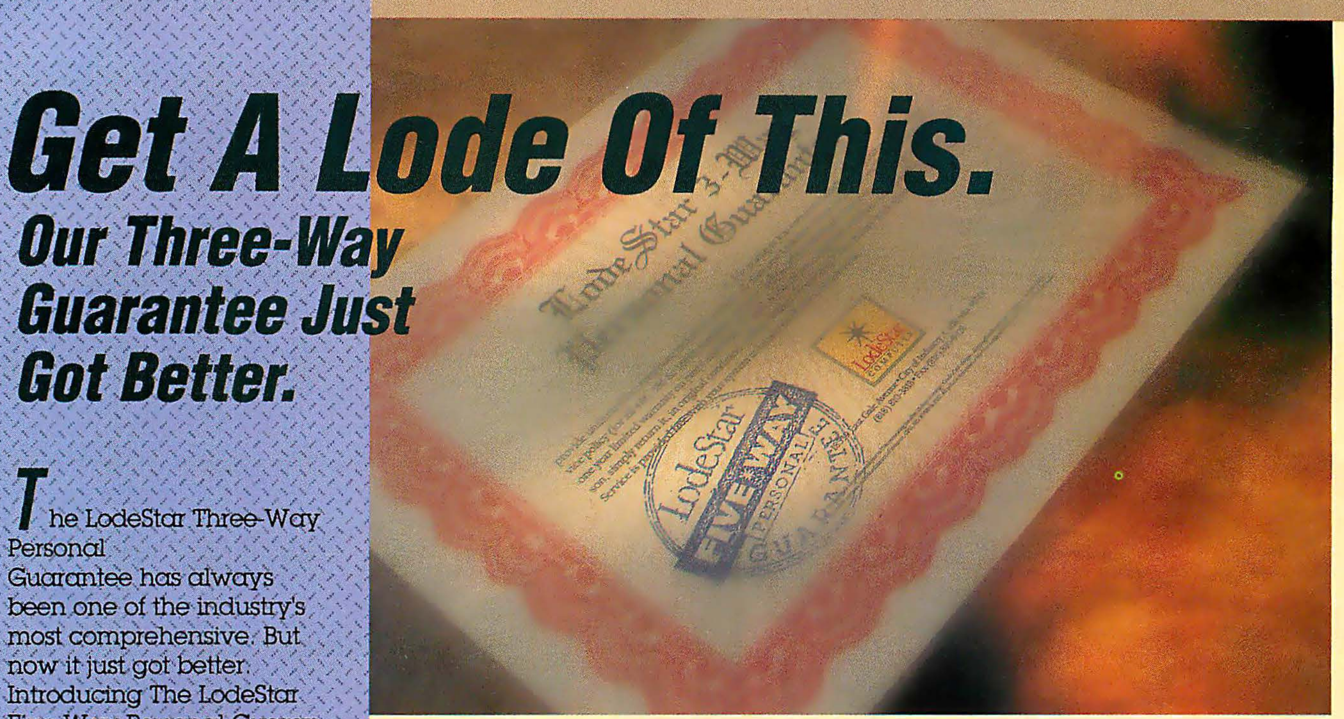
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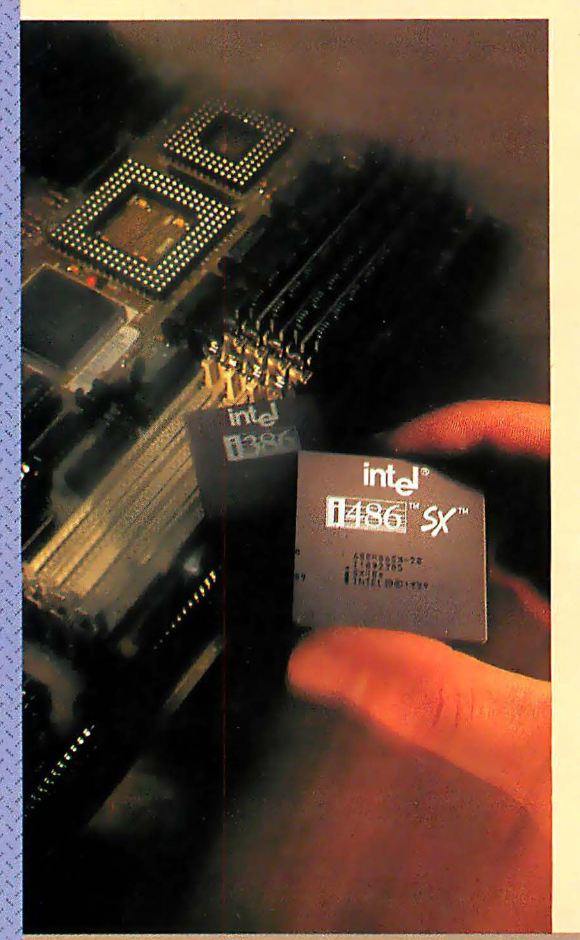
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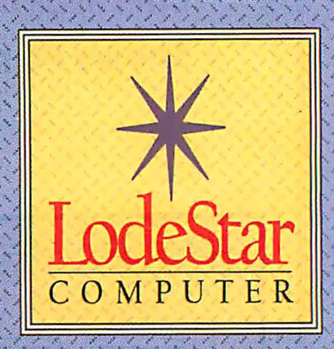
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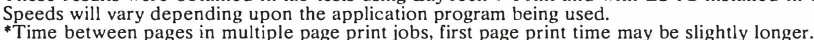
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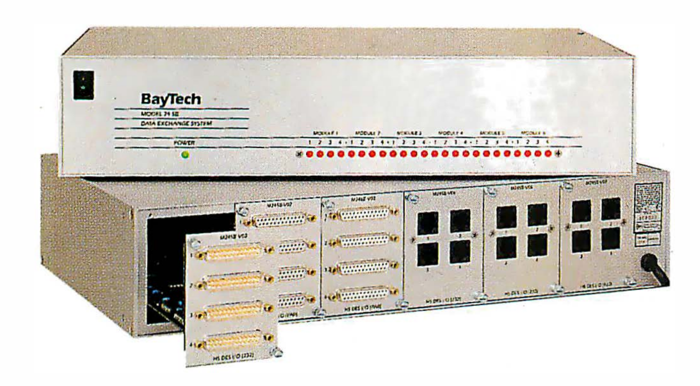
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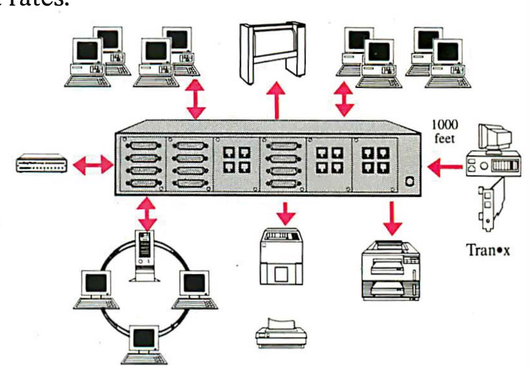


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- 32,000 COLORS!
  Standard on all Lapine Powrtools.
- PROGAMMABLE KEYBOARD
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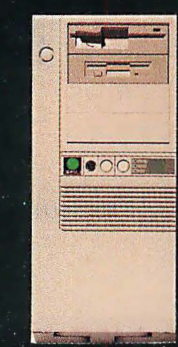
Powertools by Lapine are the office machines that make all the difference for all kinds of businesses.

Lapine is the first computer manufacturer to offer local bus computing with the S3 graphic accelerator chip for 32-bit, 33 and 50mhz processing of graphics. This means graphics that are 50x faster than standard 16-bit processing. The local bus feature is standard on LP-433L and LP-450L models.

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MEMORY

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SIMM-SIPP MODULES

4MB X 9-80NS SIMM-PC	124.00	256K X 9-80NS SIMM-PC	11.00	1MB X 9-100NS SIPP-PC	36.00
4MB X 9-70NS SIMM-PC	124.00	256K X 9-70NS SIMM-PC	13.00	1MB X 9-80NS SIPP-PC	37.00
4MB X 9-60NS SIMM-PC	138.00	256K X 9-60NS SIMM-PC	13.65	1MB X 9-70NS SIPP-PC	37.00
1MB X 9-100NS SIMM-PC	34.00	1MB X 8-100NS SIMM-MAC	32.00	1MB X 9-60NS SIPP-PC	39.00
1MB X 9-80NS SIMM-PC	35.00	1MB X 8-80NS SIMM-MAC	33.00	256K X 9-100NS SIPP-PC	11.75
1MB X 9-70NS SIMM-PC	35.00	1MB X 8-70NS SIMM-MAC	34.00	256K X 9-80NS SIPP-PC	14.65
1MB X 9-60NS SIMM-PC	37.00	4MB X 8-80NS SIMM-MAC	120.00	256K X 9-70NS SIPP-PC	15.00
256K X 9-100NS SIMM-PC	9.00	4MB X 8-70NS SIMM-MAC	120.00	256K X 9-60NS SIPP-PC	16.00

DYNAMIC RAMS

1MB X 1-100NS	4.40	256 X 1-80NS	1.80	64K X 4-120NS	1.75
1MB X 1-80NS	5.20	256K X 1-70NS	1.90	64K X 4-100NS	2.10
1MB X 1-70NS	5.25	256K X 1-60 NS	2.20	64K X 4-80NS	2.25
1MB X 1-60NS	5.30	256K X 4-100NS	4.75	64K X 1-150NS	1.50
256K X 1-150NS	1.50	256K X 4-80NS	5.20	64K X 1-120NS	1.75
256K X 1-120NS	1.55	256K X 4-70NS	5.35	64K X 1-100NS	1.95
256K X 1-100NS	1.70	256K X 4-60NS	5.40	**256K X 1-STTATIC RAM**	
1 x 4-80NS	21.00	DIPP		AAA2800P-08 (256x1)	2.65
1 x 4-80NS	21.00	STATIC ZIPP		AAA2800P-07 (256x1)	2.85
1 x 4-80NS	21.00	ZIPP		AAA2800P-06 (256x1)	3.05

CACHE MEMORY

8 X 8-15	10.00
32 X 8-15	25.00
8 X 8-25	7.00
32 X 8-25	16.80
64 X 4-25	21.00
16 X 4-25	7.00
8 X 8-20	8.00
32 X 8-20	17.50
64 X 4-20	22.50
16 X 4-20	8.00

IBM MEMORY

LASER PRINTER MODEL 4019, 4019E	1MB BOARD	1039136	$ 63
	2MB BOARD	1039137	140
	3.5MB BOARD	1038675	225
LASER PRINTER MODEL 4029	1MB BOARD	118333	115
	2MB BOARD	118334	185
	4MB BOARD	118335	290
PS/1 & 386SX	512K MODULE	1057035	70
	2MB MODULE	92F9335	170
	4MB MODULE	92F9694	320
PS/2 25	128K KIT	78X8955	28
PS/2 25/286 30-286	512K KIT	30F5348	45
	2MB KIT	30F5360	115
ABOVE INSTALLED ON EXPANSION BOARD 1497259 FOR 50, 50z & 60			
35SX, LS, 40SX PS/2 50Z, 55SX, 65SX 55LS, 65LS	2MB SIMM	6450604, 90X5625	100
35SX, LS, 40SX 55SX, 65SX	4MB MODULE	34F2933 or 87F9977	185
55LS, & 65LS ABOVE INSTALLED ON SYSTEM BOARD			
(UPGRADES W/6450603 6450640 & 34F2933	1-13MB BOARD	6450685	180
	2-14MB BOARD	6450609	260
	4-16MB BOARD	6450609	350
PS/2 70-E61, 061, 121, P70	1MB SIMM	6450603	60
	2MB SIMM	6450604 90X85 25	100
PS/2 70-A21, A61 B21 & B61	2MB SIMM	6450608	105
PS/2 80-041	1MB MODULE	6450375	88
PS80-81, 111, 121 161, 311 & 321	2MB MODULE	6450379	120
PS/2 80-A21, A31, A61	4MB MODULE	6451060	255
PS/2 90, 95 & P75 (INSTALL IN PAIRS)	2MB SIMM	6450902	130
	4BM SIMM	6450128	220
PS/2 ALL 70s & 80s	2-8MB BOARD	6450605	220
(UPGRADES W/STD SIMMS)	4-8MB BOARD	34F3011	400
	8MB BOARD		550
PS/2 ALL 70s & 80s	2-14MB BOARD	34F3077	270
	4-16MB BOARD	34F3011	380
	8-16MB BOARD		620
	16MB BOARD		940
34F3077 IS INTERCHANGABLE WITH 6450605			
RISC 6000 (NO BOARD INCLUDED)	16MB KIT	4010	1,100
	32MB KIT	4033	2,400
	64MB KIT	4036	4,500
L40SX & N335SX LAPTOP	2MB SIMM	79F0999	165
	4MB SIMM	79F1000	340
	6MB SIMM	79F1001	600
*35SX, LS & 40SX	8MB SIMM	6450129	470
*50SX, 90 & 95	8MB SIMM	6450130	490

COMPAQ MEMORY

DESKPRO 286	512K KIT	113012-001	$ 45
DESKPRO 286E	1MB MODULE	113131-001	65
	4MB MODULE	113132-001	225
DESKPRO 286N, 386N	EXP BOARD	118700-001	90
DESKPROP 286N, 386N 286SX/20, 386/25M, 486/33M, 486S/25M, 486S/16M	1MB SIMM	118688-001	70
	2MB SIMM	118689-001	110
	4MB SIMM	118690-001	210
	8MB SIMM	128877-001	460
SYSTEM PRO LT 486SX/25S, 386/25S, PORTABLE 486C NOTE: 8MB SIMM FOR M, SYSTEM PRO & PORTABLE SERIES ONLY.			
DESKPRO 386/16	1MB BOARD	108069-001	210
	2MB BOARD	108069W/71	290
	1MB KIT	108071-001	70
	4MB BOARD	108070-001	440
	6MB BOARD	108070 W/72KIT	675
	4MB KIT	108072-001	215
DESKPRO 386S	1MB BOARD	113633-001	145
	4MB BOARD	113634-001	275
	1MB MODULE	113615-001	75
	4MB MODULE	112534-001	230
DESKPRO 386/20, 20E 25 & 25E	1MB BOARD	113544-001	145
	4MB BOARD	113645-001	275
	1MB MODULE	113131-001	75
	4MB MODULE	113132-001	230
DESKPRO 386/33L 486/25, 33, 33L SYSTEMPRO	6SOCKET BD	115569-001	315
	2MB MODULE	115144-001	130
	8MB MODULE	116561-001	480
	32MB MODULE	116568-001	2,700
DESKPRO 486/33M, 486/25M, 16M, 386/25M, SYSTEM PRO LT, 486SX/25S, 386/25S	8SOCKET BD	129160-001	299

PORTABLE III	512K KIT	107331-001	35
	INTERFACE BD	107808-001	85
	EXPANSION BD	107811-001	210
	2MB KIT	107332-001	105
SLT/286	1MB MODULE	110235-001	95
	4MB MODULE	110237-001	395
LTE LTE/286	512K MODULE	117077-001	105
	1MB MODULE	117081-001	90
	2MB MODULE	117081-002	125
	4MB MODULE	117081-003	320
LTE/386S/20	1MB CARD	121125-001	170
	4MB CARD	121125-002	400
PORTABLE 386	1MB KIT	107651-001	$115
	INTERFACE BD	107707-001	100
	4MB BOARD	107653-001	375
	4MB EXTEND BD	107654-001	375
SLT/386S	1MB MODULE	118303-001	115
	2MB MODULE	118304-001	165
	4MB MODULE	118305-001	320

TOSHIBA MEMORY

PORTABLE T1000SE & XE, LE	1MB CARD	PC-PA8311U	$ 109
	2MB CARD	PC-PA8312U	160
PORTABLE T2000SX & T2000	1MB CARD	PC18-PA8316U	109
	2MB CARD	PC18-PA8317U	160
PORTABLE T2000, T2000SX & T1000LE	4MB CARD	PC1X-PA8314U	340
	8MB CARD	PC1X-PA8315U	740
*PORTABLE T2000SXE & T2200SX	2MB CARD8	PC-PA2000U	185
	4MB CARD	PC-PA2001U	395
	8MB CARD	PC-PA2002U	800
PORTABLE T1200XE	2MB MODULE	PC13-PA8306U	115
PORTABLE T1600	2MB MODULE	PC8-PA8302U	115
PORTABLE T3100E	512K KIT	PC9-PA8340U	99
	2MB KIT	PC9-PA8341U	115
PORTABLE T3100SX	2MB MODULE	PC15-PA8308U	115
	4MB MODULE	PC15-PA8310U	215
PORTABLE 3200	3MB MODULE	PC6-PA7137U	190
PORTABLE T3200SX	2MB KIT	PC12-PA8307U	115
	4MB KIT	PC12-PA8309U	215
PORTABLE T3200SXC	2MB KIT	PC19-PA8318U	125
	4MB KIT	PC19-PA8319U	225
T4400SX	2MB CARD	PC-PA2003U	220
	4MB CARD	PC-PA2004U	360
	8MB CARD	PC-PA2005U	695
PORTABLE T5100 T5100C	2MB MODULE	PC7-PA8301U	120
PORTABLE T5200C	2MB KIT	PCX-PA8304U	115
DESKTOP-T8500	8MB KIT	PCX-PA8313U	475

AST MEMORY

BRAVO 286	128K KIT	500510-011	$ 25
	512K KIT	500510-010	35
	2MB KIT	500510-002	105
	4MB KIT	500510-008	205
BRAVO 386SX/20	512K KIT	500510-012	42
	2MB KIT	500710-003	110
	8MB KIT	500824-001	395
BRAVO 86SX	2MB KIT	500510-002	110
	4MB KIT	500510-008	205
BRAVO 486/25	2MB KIT	500718-004	120
	6MB KIT	500780-001	465
PREMIUM 286 FASTRAM	512K KIT	500510-001	40
ADV-FASTRAM	1MB KIT	500510-007	60
PREMIUM WKST286.386SX	512K KIT	500510-010	35
	1MB KIT	500510-007	60
	2MB KIT	500510-002	105
	4MB KIT	500510-003	205
FASTBOARD 386 PREMIUM 386/16C	1MB KIT	500510-007	60
	4MB KIT	500510-008	205
PREMIUM WKST/286	512K KIT	500510-010	35
	2MB KIT	500510-002	105
PREMIUM 386	1MB KIT	500510-003	65
	4MB KIT	500510-001	245
PREMIUM 386/20 386/16SX	1MB SIMM	500718-001	55
	1MB SIMM	500718-002	60
CUPID-32 PREMIUM SERIES 386 DESKTOP 16SX, 25, 33	1MB SIMM	500780-003	55
	4MB SIMM	500780-004	205
	8MB KIT	500780-001	360
	CUPID BD	500818-001	295
PREMIUM II DESKTOP 386SX20 486DESKTOP-25, 25E, 33 PREMIUM TOWER 386/33TE, 486/25TE, 486/33TE PROCESSOR CARD FOR 25 & 3			
PREMIUM EXEC 386SX, 286	1MB SIMM	500814-001*	70
	4MB SIMM	500814-003*	185
NOTEBOOK 500814-001 FOR PREMIUM EXEC 286/12 ONLY			
386SX/25.25C	1MB SIMM	N/A	90
	4MB SIMM	500814-004	200

APPLE MEMORY

POWERBOOK 100	2MB MDL	M1032LL/A	$300
	4MB MDL	M1031L/A	395
	6MB MDL	N/A	550
POWERBOOK 140/170	2MB MDL	N/A	300
	4MB MDL	M1033LL/A	395
	6MB MDL	N/A	550
QUADRA 700	4MB KIT	M0292LL/A	180
	16MB KIT	N/A	640
	64MB KIT	N/A	3,500
QUADRA 900	4MB KIT	M0292LL/A	180
	16MB KIT	N/A	640
	64MB KIT	N/A	3,000
IISI	2MB SIMM	M0514LL/A	95
	8MB KIT	M0513LL/A	350
MAC LC	4MB KIT	N/A	$195
	8MB KIT	N/A	360
	512K SIMM	M0517LL/A	109
MAC IICI, IISI	1MB KIT	M0291LL/A	55
	4MB KIT	M0292LL/A	170
	16MB KIT	N/A	650
CLASSIC	1-3MB BD	M6361LL/A	75
	2MB KIT	M0219	90
MACPORTABLE	2MB BD	N/A	550
	4MB BD	N/A	750
MAC II, IIX, IICX & SE/30	1MB KIT	M0218	60
	2MB KIT	M0219	85
	4MB KIT	M0707	180
	16MB KIT	N/A	700
MAC IIFX	4MB KIT	M0376LL/A	185
	16MB KIT	N/A	650
LASER WRITER II NTX-J II F & II G	1MB KIT	M6005	75
	4MB KIT	M6006	165
	16MB KIT	N/A	650
MAC II VIDEO	KIT	M0213	50
MAXIMA	SOFTWARE	N/A	75

ALR MEMORY

VENTURA NOTEBOOK 16 & 20	1MB MODULE	12407970	$225
	4MB MODULE	12407980	1,090
POWERFLEX & 20CSX	1MB KIT	12901000	70
	2MB KIT	12902000	105
	4MB KIT	12904000	210
	16MB KIT	N/A	785
POWERPRO	4MB KIT	12904000	210
	16MB KIT	12916000	750
POWERCACHE 486 & 486E	2MB KIT	12902000	110
	8MB KIT	12904800	395
	32MB KIT	12916000	1,400
BUSINESS/ POWERVEISA	1MB KIT	12901000	70
	4MB KIT	12904000	205
	16MB KIT	12916000	805
1.32MB EXPBD		12427480	261
	4-32MB EXPBD	12447480	532
	6-32MB EXPBD	12467480	732
	16-32MB EXPBD	12487480	1,105

DELL MEMORY

450SE/DE, 420SE/DE, 433TE/SE/DE & 425TE/SE/DE	2MB KIT	310-2466	$110
	4MB KIT	310-2467	230
	8MB KIT	310-2468	420
	16MB KIT	310-2459	790
	32MB KIT	N/A	1,750
433E & 425E	2MB KIT	310-2389	110
	4MB KIT	310-2390	230
	8MB KIT	N/A	420
320N & 212N	1MB SIMM	310-3203	165
	2MB SIMM	310-3204	295
320LT & 316LT	2MB KIT	310-2494	105
	4MB KIT	310-2494	210
	8MB KIT	310-2494	420
325P/D & 333P/D	1MB MODULE	310-2505	65
	4MB MODULE	310-2507	220
325, 310, 320LS, 316 316SX & 210	1MB KIT	310-2101	70
	4MB KIT	310-2273	220

EPSON MEMORY

NBS3	1MB MODULE	A808501	$130
	4MB MODULE	A506511	365
EQUITY LT286E	1MB MODULE	A808191	116
EQUITY LT386SX	2MB MODULE	A808361	225
EQUITY IIE 386/25, 20	1MB KIT	A908091	61
	2MB KIT	A508101	111
86SX, 20, 25 & 286 486SX/25 -	1MB KIT	A808231	66
	2MB KIT	A608101	116
386SX/20 -	8MB KIT	A808631	600

EVEREX MEMORY

TEMPO/LX	2MB MODULE	PCA-000053-00	$ 180
TEMPO/LX20	2MB MODULE	PCA-000054-00	200
TEMPO 286	512K KIT	N/A	40
	2MB KIT	N/A	125
TEMPO 386SX	1MB KIT	N/A	60
	2MB KIT	N/A	125
	4MB KIT	N/A	225
CACHE KIT	64K	N/A	70
286 STEP 12, 16	1MB KIT	N/A	60
	2MB KIT	N/A	100
	4MB KIT	N/A	225
286 STEP 230	1MB KIT	N/A	60
	2MB KIT	N/A	100
	4MB KIT	N/A	225
386 STEP 16, 20, 25	1MB KIT	N/A	60
	2MB KIT	N/A	100
	4MB KIT	N/A	225
STEP 386/33	4MB MDL	N/A	225
	64K MDL	PWA-00582-00	230

HP VECTRA MEMORY

486PC, 48633T/25T (INSTALL IN PAIRS) 486S/20	1MB SIMM	D2150A	$70
	2MB SIMM	D2381A	125
	4MB SIMM	D2156A	205
	8MB SIMM	D2125A	450
386QS/25	2MB SIMM	D2381A	125
	8MB SIMM	D2125A	450
QS/16S & RS/20PC	1MB KIT	D1540A	65
QS/16S & ES/12PC	2MB KIT	D1354A	105
QS/16S & RS/20PC	4MB KIT	D1542A	215
QS/20PC & RS/25PC	1MB KIT	D1640A	65
	4MB KIT	D1642A	215
LS/12	1MB MODULE	D1054A	150
9000 SERIES 425E	4MB BDSET	A2200A	425
	8MB BDSET	A2201A	840
	16MB BDSET	A2202A	1,575
345, 375, 433S, 400S, 425T, 400DI, 400T	4MB BDSET	H98229C	425
	8MB BDSET	H98223B	840
	16MB BDSET	H98229D	1,575
	32MB BD SET	H98229E	3,250

LAPTOP MEMORY

BONDWELL			
B310 SUPERSLIM	1MB MODULE	E23050-09100	$150
COMMODORE			
LAPTOP	2MB MODULE	390850-01	150
GOLDSTAR			
GS520 386SX/16	1MB MODULE	N/A	135
	4MB MODULE	N/A	350
LEADING EDGE			
D.LT386SX	1MB MODULE	230509100	100
PACKARD BELL, MAGNAVOX & MITSUBA			
PB286NB	1MB MODULE	N/A	170
	4MB MODULE	N/A	395
PB386NBX	1MB MODULE	N/A	170
	2MB MODULE	N/A	205
	4MB MODULE	N/A	395
PANASONIC			
CF170/270/370 (INSTALL IN PAIRS)	1MB MODULE	CF-BA165	121
SAMSUNG			
NOTEMASTER 386S	2MB MODULE	SNM002	210
	4MB MODULE	SNM004	405
SANYO			
17NB, 18NB	2MB MODULE	MBC-NBMEM2	145
SHARP			
PC-6220	1MB MODULE	CE-621B	122
PC-6640	2MB KIT	N/A	195
PC-4700MZ-200	1MB MODULE	CE471	180
PC-8501 COLORSTAR	2MB MODULE	N/A	280
TANDON			
NB386SX	1MB MODULE	N/A	115
	4MB MODULE	N/A	270
TI			
TRAVELMATE 2000	1MB MODULE	2568034-0001	110
TRAVELMATE 3000	2MB KIT	2566996-0001	145

NEC MEMORY

POWERMATE SX PLUS	1-8MB BD	APC-H850E	$218
	1MB KIT	APC-H851E	66
	2MB BD	APC-H852E	255
	4-8MB BD	APC-H250E	415
	8MB BD	N/A	772
POWERMATE 386/16 & 20	4-16MB BD	N/A	766
	8-16MB BD	N/A	988
	16MB BD	N/A	1,322
POWERMATE/ BUSINESS 386/25S	4-16SMB BD	N/A	527
	8-16MB BD	N/A	772
	16MB BD	N/A	1,250
POWERMATE/ BUSINESS 386/25S	2MB KIT	OP-410-5201	$150
	8MB KIT	OP-410-5202	422
POWERMATE SX 20	2MB MODULE	OP-410-8101	211
	2-8MB BD	OP-410-5102	210
	2MB KIT	OP-410-5103	140
POWERMATE SX/16	2-6MB BD	OP-410-8201	210
	2MB KIT	OP-410-6103	140
POWERMATE SX	2MB BD	APC-H855	527
	4-8MB BD	APC-H853	744
	6MB BD	N/A	1,222
POWERMATE 386/33E & 486/25E	2MB MODULE	OP-41-5101	225
POWERMATE PORTABLE SX	2MB MODULE	APC-H751X	327
	8MB MODULE	APC-H753X + H754X	1,166
ULTRALITE 286F	1MB MODULE	PC-22-21	185
	4MB MODULE	PC-22-22	495
ULTRALITE SX/20	2MB MODULE	PC-44-21	275
	8MB MODULE	PC-44-22	705
PROSPEED 286 & 386SX/16	1MB MODULE	PC-21-21	145
	4MB MODULE	PC-21-22	450
PROSPEED SX/20	1MB BD	PC-43-21	185
	4MB BD	PC-43-22	385
PRTOSPEED 386	2MB	PC-31-21	200
	6MB	PC-31-22	875
POWERMATE PORTABLE PLUS	1-3MB BD	APC-H750J	385
	2-3MB BD	H750+751	395
	3MB BD	750+12J751	495

NCR MEMORY

PC286, ELPC386SX	2MB KIT	3302-K102	$162
NCREXPBD	2MB KIT	3279-K119	162
PC386SX/20	1MB KIT	3304-K105	102
	2MB KIT	3304-K106	162
	8MB KIT	3304-K107	630
PC386SX/MC20	2MB MODULE	3421-K202	180
	2-14MB EXPBD	N/A	270
	4-14MB EXPBD	N/A	366
PC486 MC25	2MB KIT	3314-K102	300
	8MB KIT	3314-K104	570
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TURBOSPORT 386E	1MB MODULE	ZA3034ME	170
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SUPERSPORT SX	2MB MODULE	ZA180-64	185
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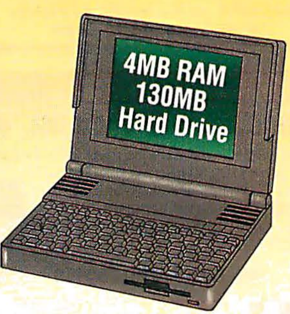
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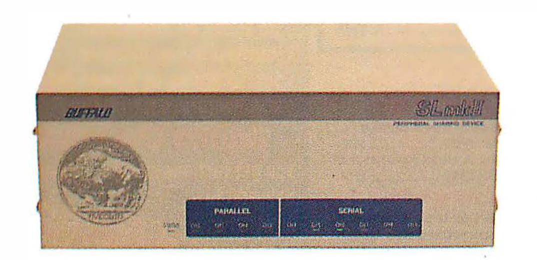
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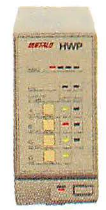
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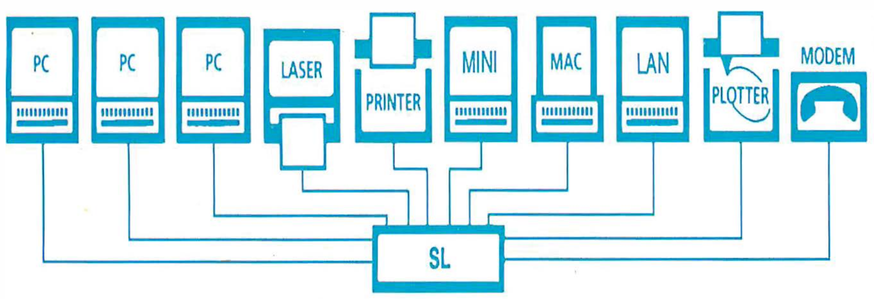








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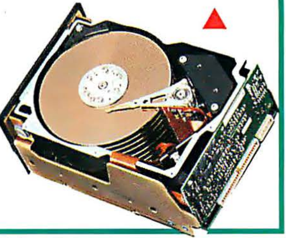
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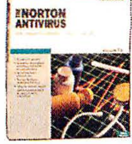
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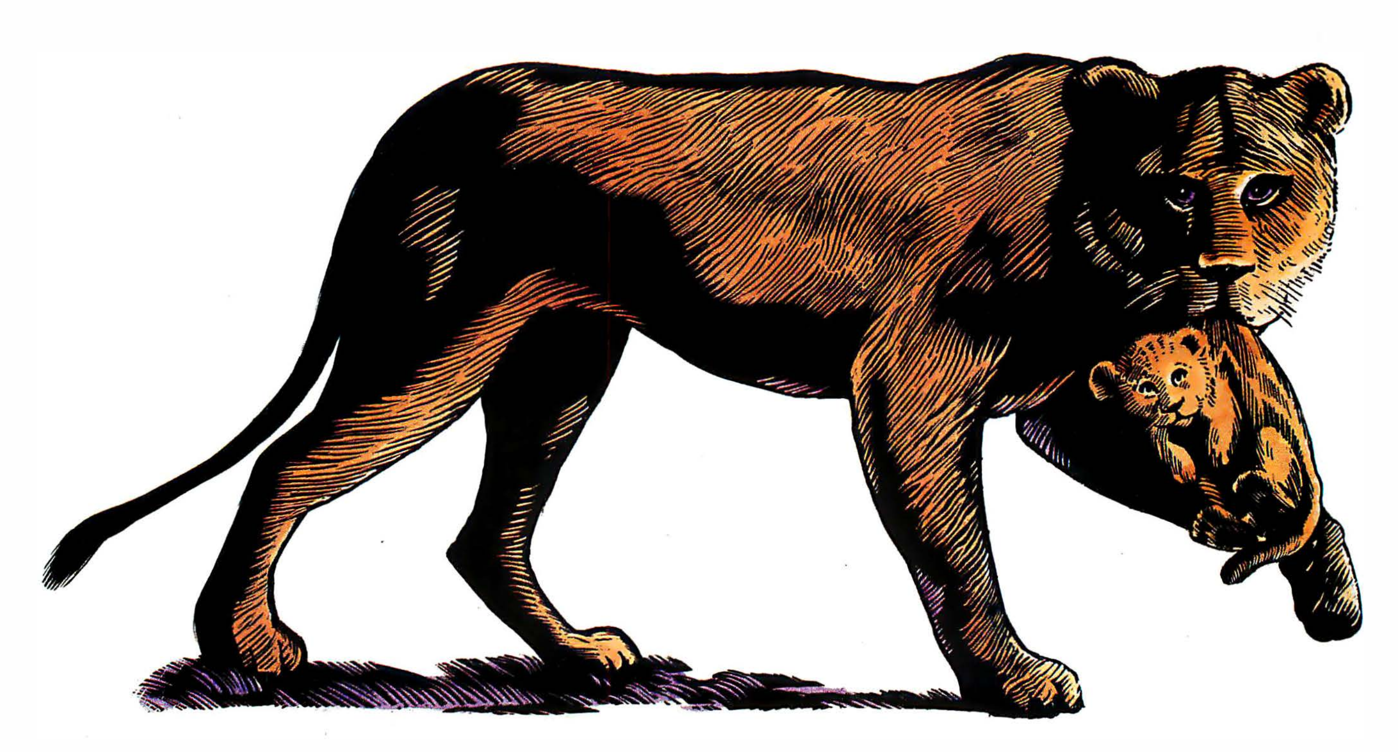
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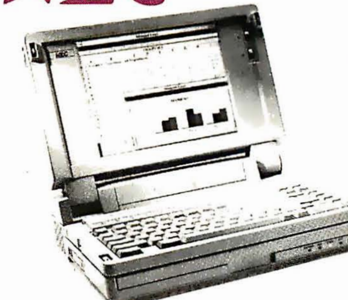
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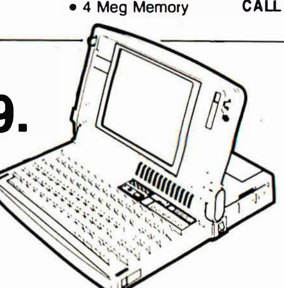
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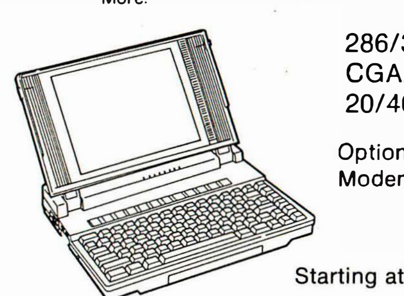
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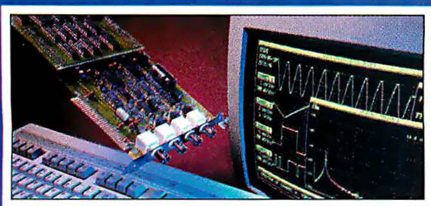
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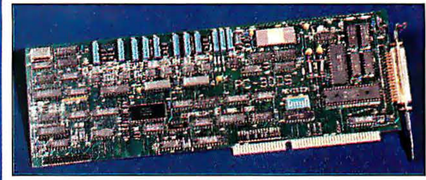
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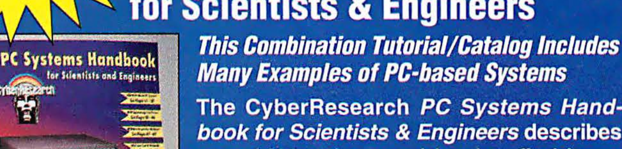


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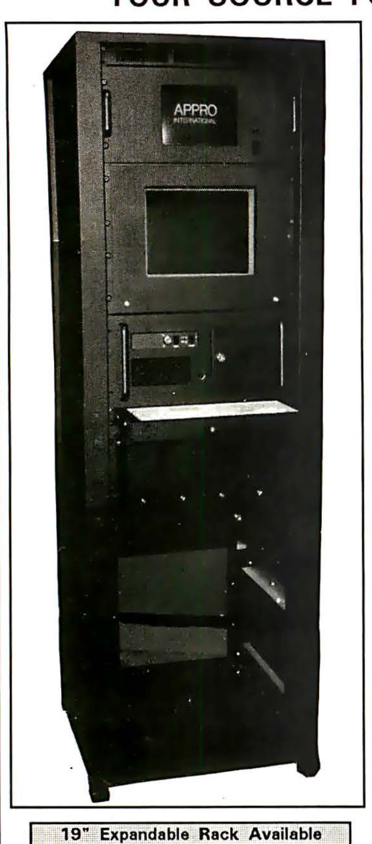
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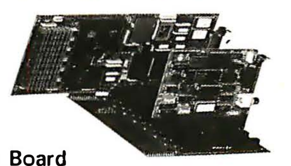
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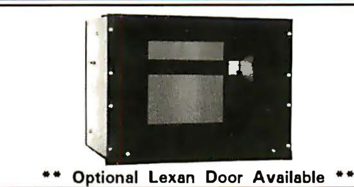
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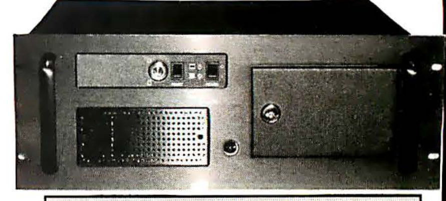


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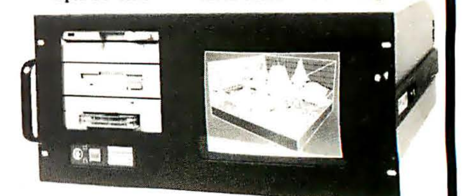
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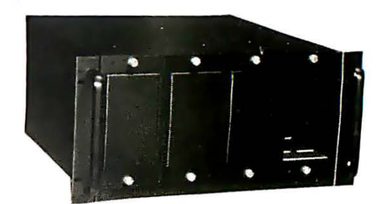


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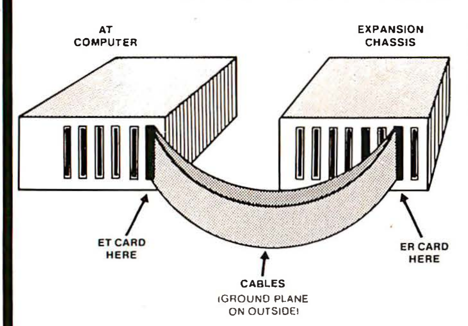
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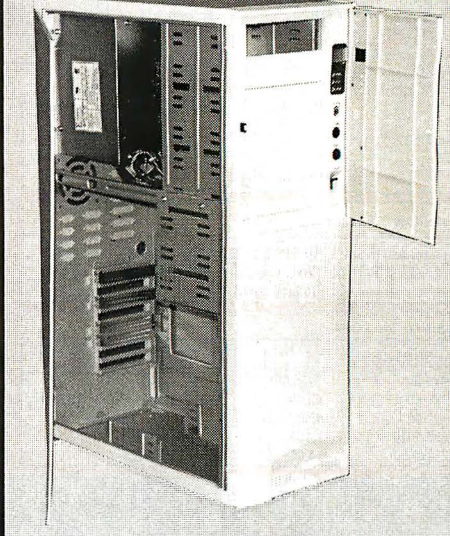
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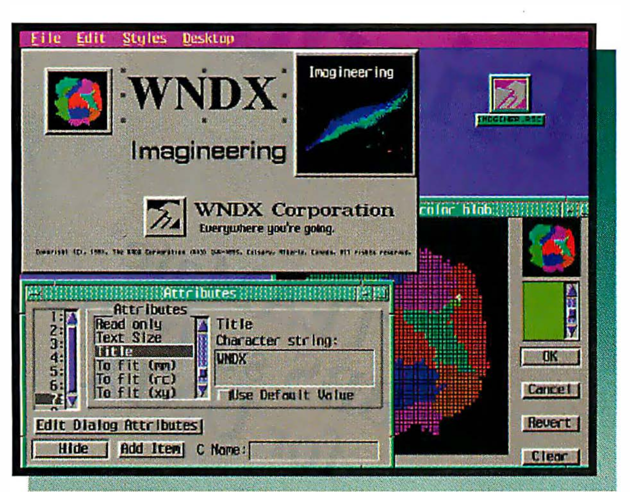
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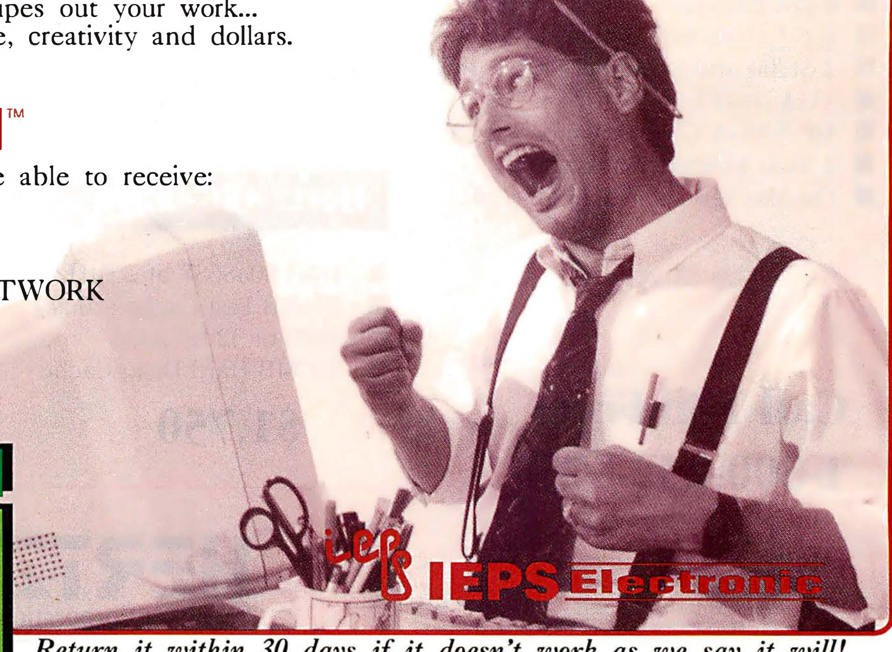
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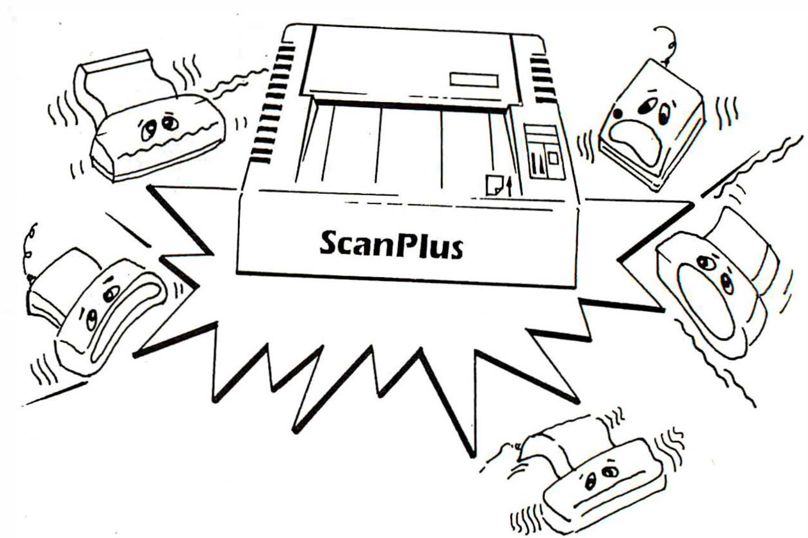
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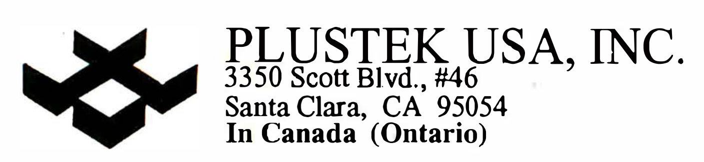
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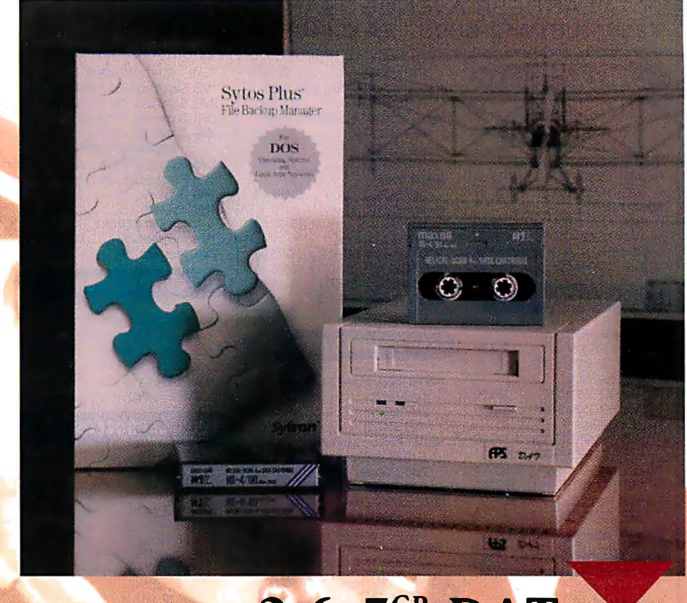
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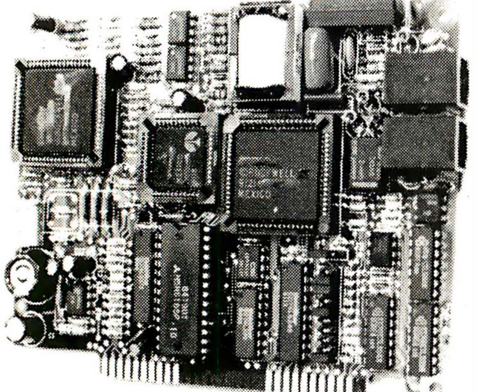
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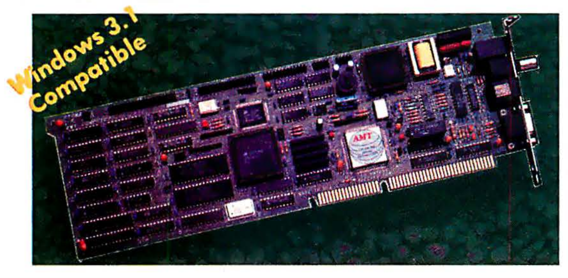
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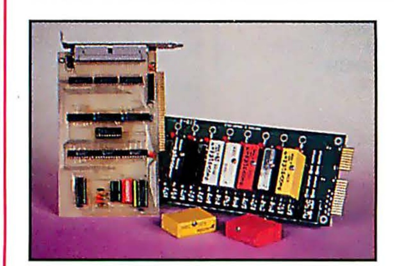
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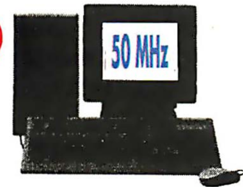
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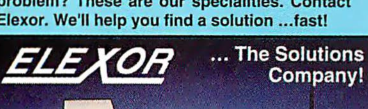


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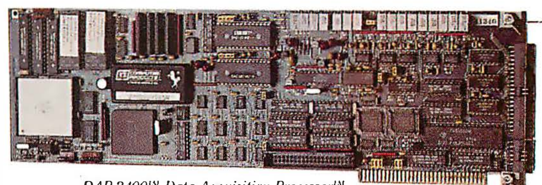
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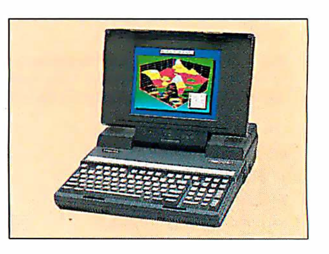
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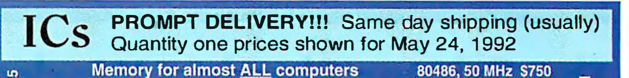
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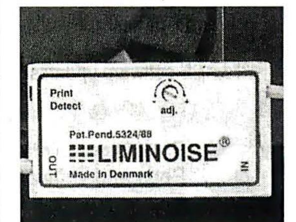
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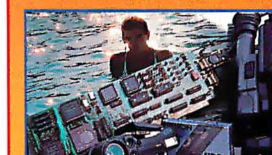
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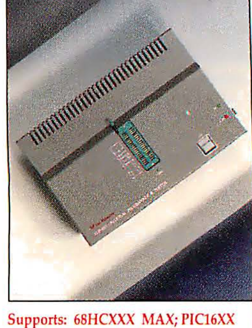
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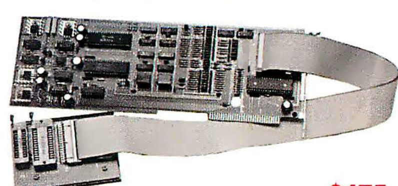
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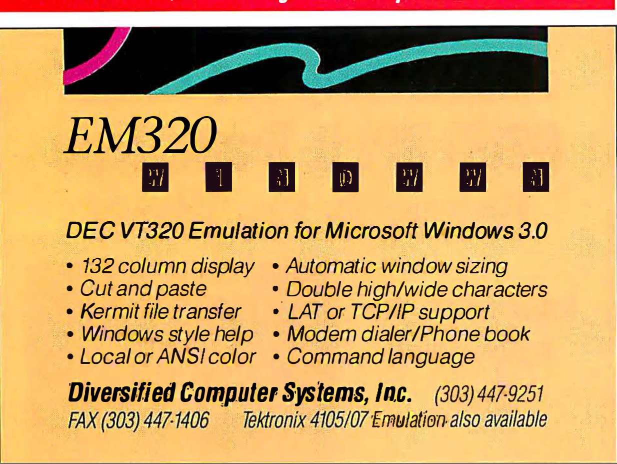
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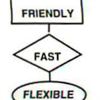
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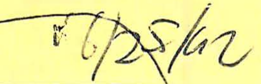
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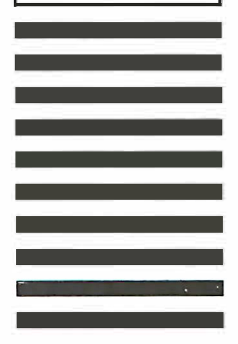
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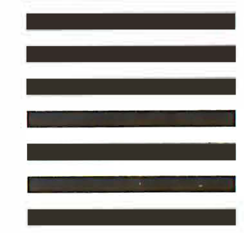
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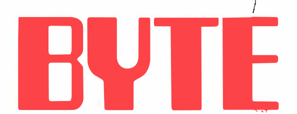






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1 ☐ MIS/DP
2 ☐ Programmer/Systems Analyst
3 ☐ Administration/Management
4 ☐ Sales/Marketing
5 ☐ Engineer/Scientist
6 ☐ Other

B. What is your level of management responsibility?
7 ☐ Senior-level
8 ☐ Middle-level
9 ☐ Professional

C. Are you a reseller (VAR, VAD, Dealer, Consultant)?
10 ☐ Yes
11 ☐ No

D. What operating systems are you currently using? (Check all that apply.)
12 ☐ PC/MS-DOS
13 ☐ DOS + Windows
14 ☐ OS/2
15 ☐ UNIX
16 ☐ MacOS
17 ☐ VAX/VMS

E. For how many people do you *influence* the purchase of hardware or software?
18 ☐ 1-25
19 ☐ 26-50
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STOP BIT

GEN. COLIN L. POWELL

INFORMATION-AGE WARRIORS

Personal computer technology may determine the outcome of future conflicts

The Information Age has dawned in the armed forces of the U.S. The sight of a soldier going to war with a rifle in one hand and a laptop computer in the other would have been shocking only a few years ago. Yet that is exactly what was seen in the sands of Saudi Arabia in 1990 and 1991. Information systems have become essential ingredients to the success of combat operations on today's battlefield. And the explosion of personal computer technology has brought with it a new set of challenges.

In the Persian Gulf War, personal computers permeated all layers of command and all functions of combat operations. Their diverse functions included providing target data for aircraft and missiles, coordinating the flow of supplies and equipment into the area, and maintaining personnel databases. They were also used to analyze intelligence information, plan routes for aircraft flights and troop marches, identify troop locations, diagnose radar systems, and move messages from one corner of the battlefield to another.

At the height of the conflict, the automated message-information networks passed nearly 2 million data packets per day through gateways in the Southwest Asia theater of operations. The tremendously complex buildup, the merging of U.S. and coalition forces, and the movement of the massive amount of supplies required to support the forces were accomplished smoothly, due in large part to personal computer technology. Battlefield information systems became the ally of the warrior. They did much more than simply provide a service. Personal computers were *force multipliers*. Efficient management of information increased the pace of combat operations, improved the decision-making process, and synchronized various combat capabilities.

There are challenges still ahead, however. With the proliferation of tactical computer systems and programs, interoperability among systems is crucial. The numerous generations and configurations of automated data-processing architectures and the complex methods of information and data exchange must be standardized for better effectiveness. In fact, innovation has outpaced interoperability. The lack of enforced standards and other factors have resulted in systems that cannot talk to one another. Consequently, the war-fighter is being inundated with more information in more formats.

From the commander's perspective, information received should provide an accurate description of friendly, enemy, and neutral elements in an area of concern—the "battlespace." To provide the detail and quantity of information required, a distributed database needs to be created from information provided by all available sources. Intelligence, operational, logistical, and administrative information must be fused and distributed in such a way that it can be pulled from this global "infosphere" on demand.

This aggregate information should be analyzed to merge duplicated information into a single element. The expanding discipline of AI gives great promise of help. The presentation of this information is also important. Air, ground, and naval commanders each need a different picture of the battle area; logisticians need yet another. Each should have the ability to shape the presentation of information as desired. Software-controlled customizing of each command node is the goal.

Long-term challenges also exist. True interoperability requires maximum information sharing among all services, theater commanders, and allied nations. This drives the military toward the emerging national and international information-systems standards. Future information needs on the battlefield will demand quantum leaps in processing power and memory capacity without increases in size and power consumption. Tomorrow's war-fighter will require global access to information and transparent multilevel security in a laptop system.

The ultimate goal is simple: Give the battlefield commander access to all the information needed to win the war. And give it to him when he wants it, where he wants it, and how he wants it.

A downsized force and a shrinking defense budget result in an increased reliance on technology, which must provide the force multiplier required to ensure a viable military deterrent. Increasingly, military requirements are being met by off-the-shelf hardware and software. Cost also drives the military toward commercial products. The military has always depended on industry, and that dependence has been continually rewarded. As the sun of the Information Age moves steadily toward apogee, new information-technology applications will spin off to ensure that America's fighting forces maintain the edge so proudly demonstrated in Desert Storm. ■

Gen. Colin L. Powell is chairman of the Joint Chiefs of Staff and serves as the principal military adviser to the president. You can contact him on BIX c/o "editors."

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